MAY 1960

Power Engineering

ATOMICS . . . Special Bi-Monthly News Report From the Field 41

Increased Engine Output and Fuel Economy Shown in Diesel Costs 50

What Are We Doing to Protect Our Water Resources From Pollution? 53

Follow These Simple Rules for Better Maintenance of Compressors 56

How We Monitor Silica Automatically in 2600-Psig Boilers 58

Why Not . . . Boiler Feedwater Supplied From Flash Evaporators? 60

Pneumatic Transmission Simplifies the Maintenance of Plant Pressures 63

Steel Tanks in the Power Field—Their Maintenance, Painting, and Costs 66

Important Facts About Modern Incinerator Stacks and Ash Disposal 69

To Forestall Motor Operating Problems, Know Your Bearings 71

British Cost Experiences With Hyperbolic Cooling Towers 74

How the Widow's Creek Station Will Use High-Pressure Piping 76

Another Authority Takes a Critical Look at Power Field Automation 77

APC Foresees Many Changing Shapes in the World of Power Engineering 78

Do You Understand the "Dangerous Conditions" in Steam Operation? 81

What's Your Diesel I. Q.?—A Self-Evaluation Examination 84

REGULAR DEPARTMENTS

Engineers' Preview 3

What They Tell Us 6

Helpful Bulletins 31

TRACERS 49

News Reel 64

Power Engineering Handbook 81

Construction News 88

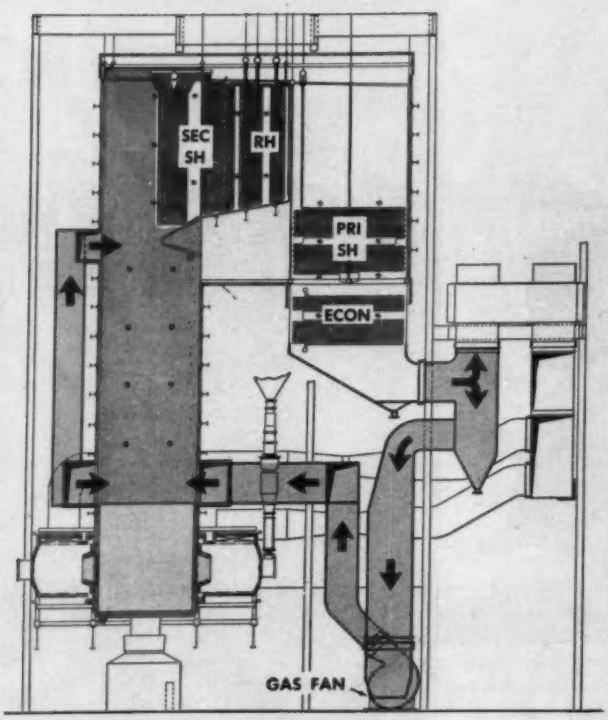
Equipment News 108

Advertisers' Index 120

Circulation of This Issue 43,130

——Gas Tempering **Report No. 4**——

"105 Years" on-the-line Prove B&W Gas Tempering



Introduction of "cool" flue gases near furnace exit prolongs superheater tube life, reduces superheater maintenance, cuts alloy requirements, and prevents slagging with even low grade coals.

105 years of unit generating experience is B&W's proof that gas tempering is the better way to provide an advanced degree of superheater tube protection.

Gas tempering in these boilers protects superheater tubes from excessive gas temperature, eliminates "enameling" of molten slag on tube convection surfaces — a major problem in burning low grade coals — reduces superheater maintenance and permits economies in over-all plant construction.

In a drum type or a B&W Universal Pressure® Boiler, gas tempering offers the solution to many vexing and often cost-building problems. For an analysis of gas tempering, and illustrations of its application, write for bulletin G-96. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

G-960

B&W

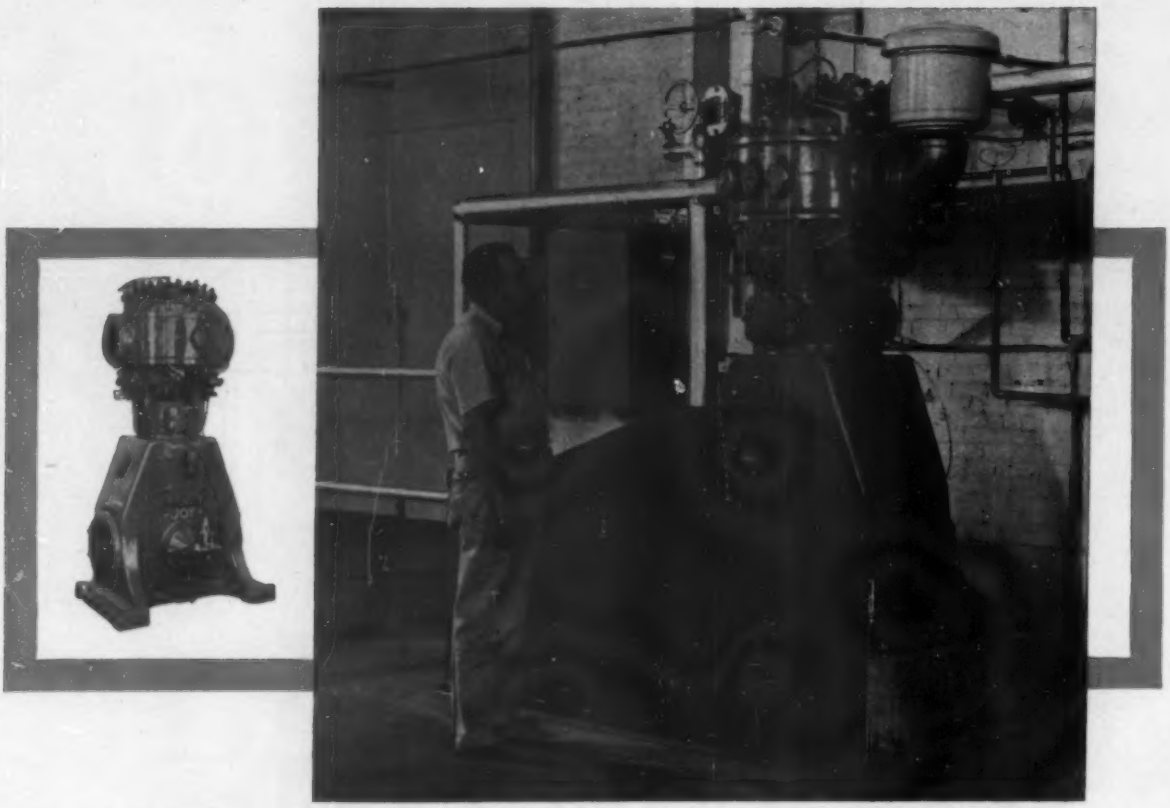
THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

For more data circle 501 on Post Card

Now Available Up To 150 HP

NEW JOY WG9H VERTICAL COMPRESSORS



Joy's line of highly efficient vertical type compressors has been extended to 150 hp. These new heavy duty WG9H's have the same design features which established the vertical type, single-cylinder compressor's reputation for high efficiency and low maintenance.

You can get both standard and oil-free machines in six standard atmospheric air sizes, with appropriate cylinders for gas boosting and high pressure applications, if desired. Capacity range is from 633 to 1630 cfm.

Other Joy vertical type compressors are available in a range from 15 to 75 hp. Joy also can furnish V-type and semi-radial type machines up to 1250 hp, and axial or centrifugal compressors from 15 to 15,000 hp. Whatever your air or gas compressing problems may be, Joy can supply an economical solution.

For full information on the new line of WG9H Compressors, write for Bulletin 1013-56C.

AIR MOVING EQUIPMENT FOR ALL INDUSTRY

JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

For more data circle 502 on Post Card

EDITORIAL AND BUSINESS STAFF

POWER ENGINEERING IS PUBLISHED MONTHLY
308 E. JAMES ST., BARRINGTON, ILL.
DUnkirk 1-1840
Chicago NEwcastle 1-0488

EDITORIAL AND ART STAFF

Editorial Director	Richard H. Morris
Editor	Robert F. McCaw
Special Projects Editor	Chester R. Earle
Associate Editor	Weldon Reynolds
Editorial Assistant	William T. Marshall
Equipment Editor	Marian E. Henken
Editorial Assistant	Mildred Nawassi
Art Director	James E. Wilcox
Staff Artist	Richard Trefilek
Staff Artist	Alice Wheatley
Editor of ATOMICS	Andrew W. Kramer

OFFICERS AND BUSINESS STAFF

President	Kingsley L. Rice
Vice President	Edwin C. Prouty, Sr.
Executive Vice President and Treasurer	Arthur L. Rice, Jr.
Secretary and Director of Circulation	Edwin C. Prouty, Jr.
Production Director	John O. Aarvold
Production Manager	Earl R. Noren
Assistant Advertising Manager	Josephine Gear
Research Manager	Margaret Hoagland
Technical Assistant to President	Andrew W. Kramer

DISTRICT MANAGERS

Chicago 3, Ill. 110 S. Dearborn St.	Warren F. Saas DEarborn 2-5453
New York City & New England 842 Graybar Bldg. New York 17, N. Y.	William H. Relyea, Jr. LExington 2-0308
Philadelphia, Pa., and New Jersey 15 Sunrise Drive Morris Plains, N. J.	Joseph E. Halloran JEfferson 8-7873
Pittsburgh 19, Pa. 404 Frick Bldg.	Robert R. Anderson COurt 1-4940
East North Central 2120 Shenandoah Road Toledo, Ohio	William B. Davis JEfferson 6-7947
California 1145 Wellington Ave. Pasadena, Calif.	Connie J. Grabb, Jr. MUrray 1-6004

WESTERN SALES MANAGER

John R. Morrison

McDonald-Thompson Offices:

Seattle 4, Wash. 1008 Western Ave.	Harry Abney MAin 3-3766
Denver 3, Colo. 620 Sherman St.	Robert Heidersbach KEystone 4-4669
Houston 6, Texas Room 214, 3217 Montrose Blvd.	Frank Vickrey JAckson 9-6711
Dallas 19, Texas 2727 Oak Lawn Ave.	Parker Harris LAkeside 1-1266

Change of Address: Send to POWER ENGINEERING, Circulation Division, Barrington, Illinois. Please supply your position title, company name, company address. Please allow 60 days to make the change effective.

Subscription Information: Published monthly, price in U.S. and possessions $10 per year; in Canada $11 per year; other countries $12 per year; single copies $1.

Indexed in the Industrial Arts Index and the Engineering Index on file in public and many private libraries.

Microfilm edition: Request prices from University Microfilms Inc. Ann Arbor, Mich. All volumes since 1948

Copyright 1960 by Technical Publishing Co., Barrington, Illinois. Accepted as controlled circulation publication at Concord, New Hampshire

PUBLISHED SINCE 1896 FOR POWER ENGINEERS IN PRIVATE AND PUBLIC UTILITIES AND INDUSTRIAL ARTS

ENGINEERS' PREVIEW

SHARP INCREASES in the use of electricity by all major classes of customers enabled Commonwealth Edison Co in 1959 to set a new sales record of 21,310,195,000 kwh. This represented an over-all gain of nearly two billion kwh, or 10.2 per cent, over 1958. Industrial sales increased 12.1 per cent, while residential and commercial gained 11 per cent and 9.3 per cent, respectively.

Allis-Chalmers has combined its Industrial and General Products Divisions into a new operating unit called the Industrial Equipment Division, with W. M. Wallace as a vice-president and general manager of the new division.

Allis-Chalmers has also organized a Power Systems Engineering Department under the management of T. G. A. Sillers. The new department will provide special services and coördination in long-range planning and development of systems and in the application of products for the generation, transmission and distribution of electric power. It will also handle commercial inquiries on complete power plant applications. C. W. Bloedorn has also been named to the new department.

General Electric has re-assigned its Atomic Products Division to its newly-formed Electric Utility Group, headed by Clarence H. Linder.

Solar Aircraft Co has become one of the group of companies that make up International Harvester Co. Solar will maintain its corporate identity, operating as a subsidiary company of International Harvester.

Combustion Engineering has been awarded a contract by Commonwealth Edison for a steam generating unit to be built at Will County Station near Lemont, Ill. Unit will serve a 510,000-kw turbine generator and will be the first unit of this capacity to be purchased by a privately-owned utility company. Rising to the height of a 20-story building, this giant will generate 3,900,000 lb of steam per hour at a pressure of 2500 psi and a temperature of 1000 F.

National Safety Council's Award of Honor has been presented to Chrysler Corporation's Engineering Division for its achievement in operating 4,275,116 man-hours without a disabling injury. During 1959 the division reduced its accident frequency rate by 41 per cent and its accident severity rate by 45 per cent over the previous year. Approximately 6000 employees work in Chrysler engineering facilities.

Coal pipeline between the Cleveland Electric Illuminating Co's Eastlake Plant and southern Ohio coal fields operated in 1959 at a somewhat higher level than its designed capacity. Its 1959 deliveries totaled 1,400,000 tons, 40 per cent of the company's entire fuel requirements.

Republic Flow Meters Co, Chicago, and Thompson-Ramo-Wooldridge Products Co, Beverly Hills, Calif, will coöperate in designing and furnishing complete computer-operated systems for the electrical power industry.

British Newfoundland Corp (Brinco) will build a 120,000-kw hydro plant near Hamilton Falls, Labrador. The project, including transmission lines, is scheduled for completion in the summer of 1962. Iron Ore Co of Canada and Wabush Iron Co have agreed to buy the power for use mainly in the new iron mines opening up in the Wabush Lake area, some 100 miles from the power site.

THREE NEW ASM Metal Awards have been established by the trustees of the American Society for Metals. Two of the new awards will be given in honor of the late William Hunt Eisenman, a founder member of the Society and its national secretary for 40 years. The third is in the name of the late Dr. Marcus A. Grossmann, a past president of the 31,000-member metals engineering society.

The Eisenman Engineering Award will be given each year to that person whose achievements have accomplished significant improvement in metallurgical processing. The Eisenman Teaching

Award will be presented to a teacher of long standing reputation through his ability to inspire students and impart enthusiasm and understanding. This is not necessarily an annual award.

The Marcus A. Grossmann Young Authors Award will be granted to the authors under age 35 of the most outstanding paper in ASM Transactions.

FINAL DESIGN and foundation construction have been completed for three portal-type transmission towers for General Electric Co's experimental Project EHV, now being built in western Massachusetts.

Portal-type towers are used in the 0.65-mile northern or "short" section of the transmission line. This type of construction permits changing conductor and phase configurations to obtain basic data on such EHV transmission problems as corona loss and radio noise.

The remaining 15 towers in the "long" southern section of the line will be of more typical construction and will utilize a wide variety of materials including four kinds of steel, aluminum, laminated wood and prestressed concrete. When finished this year, the 4.5-mile line will be a complete prototype power system operating from 460 to 750 kv — the highest transmission voltages ever attempted.

Another experimental EHV transmission line is to be built, this one by American Electric Power Service Corp and Westinghouse. It's also a 750-kv line, to be located at Apple Grove, W. Va. First tests are scheduled for late this year or early in 1961.

NEWLY-ORGANIZED Engineering Visitors Committee of the Metropolitan Section of the American Society of Civil Engineers is making things easy for foreign engineers who wish to take a close look at engineering projects in New York City. Committee was formed after a survey disclosed that foreign engineers on tour through the States have long lamented their inability to see anything more than the Empire State Building or the United Nations on stopovers in New York. The visitors' committee is remedying this situation by acting as central referral service to arrange trips to local projects. Chairman is A. Edward Dembitz.

PROJECT MERCURY of the National Aeronautics and Space Administration will be the first tracking and ground instrumentation system to encircle the globe. Western Electric is prime contractor on the $30,000,000 project. Construction has already begun on the 18 sites which make up the world-wide chain of ground stations. When completed in 1961, they will scan the heavens with an electronic eye and ear as America's first astronaut orbits the earth in space at 18,000 mph.

Project Mercury will have a computing and communications center at the Goddard Space Flight Center, Beltsville, Md, and a control center at Cape Canaveral. The 18 stations comprising the tracking and ground instrumentation system will include Cape Canaveral, Grand Bahama Island, Grand Turk Island, Bermuda, specially equipped radar picket ships in the Atlantic and Indian oceans, the Canary Islands, two sites in Africa, West and South Australia, Canton Island, Hawaii, two on the West Coast, White Sands (N. M.), Southern Texas, and Eglin Air Force Base, Fla.

REVISIONS of two American Standards for the prevention of explosions from coal dust have been approved by the American Standards Association. They are American Standard Code for the Installation and Operation of Pulverized Fuel Systems, Z12.1-1959, and American Standard Code for the Prevention of Dust Explosions in Coal Preparation Plants, Z12.7-1959. These publications are available at 50 cents each from the American Standards Association, Dept. PR127, 10 East 40th Street, New York 17, N. Y.

PRINCIPLES of operating and servicing two-way radio equipment are covered in a home study course offered by the newly-established Motorola Training Institute. This course is intended for the technician who already has basic electronic knowledge and experience sufficient to pass a Federal Communications Commission technical license examination. The Motorola Training Institute will supply a free entrance examination upon request to help a prospective student evaluate his ability to complete the course. Write the Motorola Training Institute, 4501 W. Augusta Blvd, Chicago 51.

A 17-YEAR-OLD Minnesota farm boy who built an ion accelerator by using such unusual items as a float from a pig watering trough and a Christmas tree ornament has been chosen as one of the nation's most promising young scientists. Jerome G. Spitzner of St. James, Minn., was selected from a field of 29,000 high school seniors from every state in the union as winner of the $7500 Westinghouse Science Scholarship — top award in the 19th annual Science Talent Search.

MEETINGS: 2nd Southwestern Metal Congress and Exposition is scheduled for Dallas, Texas, May 9–13.

11th annual Appliance Technical Conference of AIEE is being held May 16–17 at the Mansfield-Leland Hotel, Mansfield, Ohio.

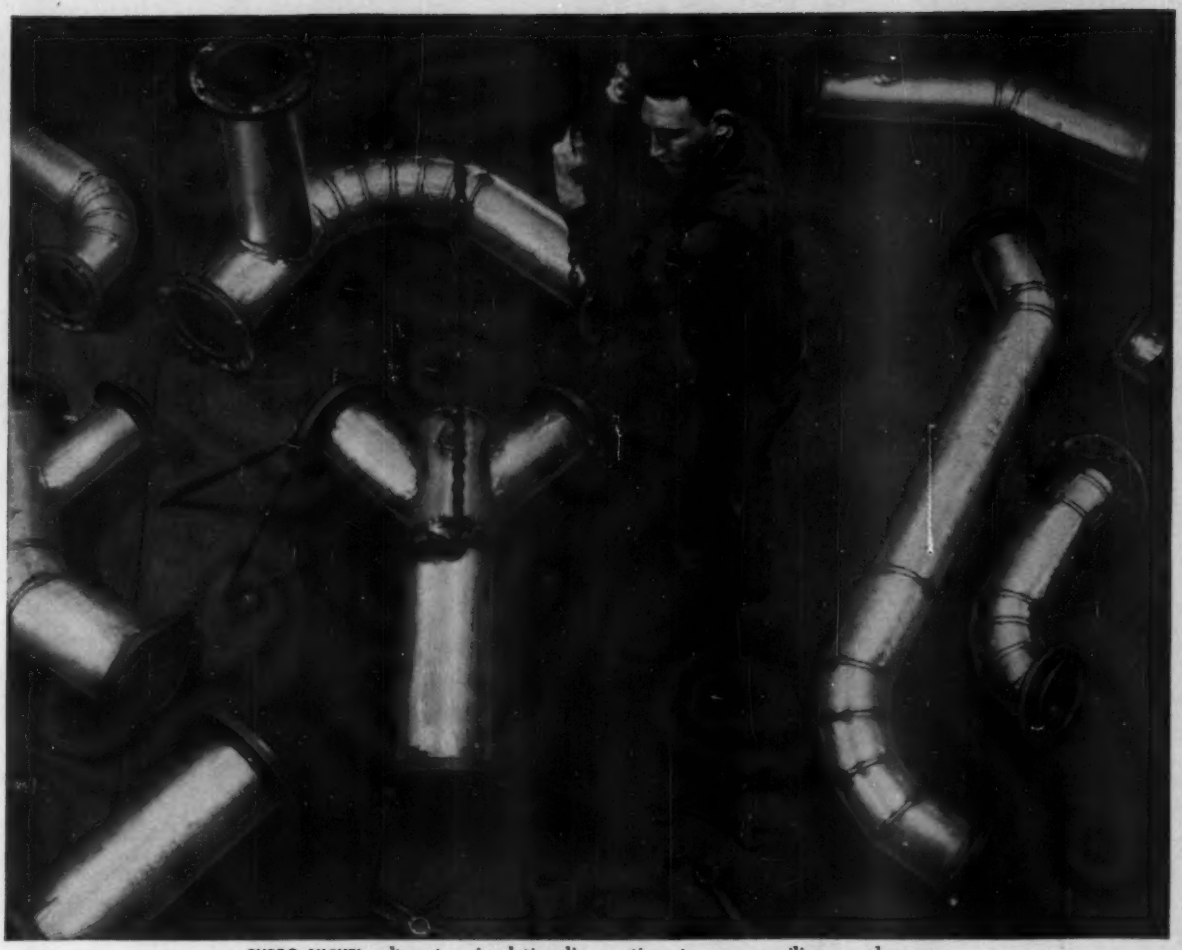
Design Engineering Show, largest exposition devoted to research and development, opens at the New York Coliseum May 23, will run through the 26th.

National Society of Professional Engineers meets in Boston, June 8–11, Hotel Statler-Hilton.

AIEE's Summer General Meeting will be held in Atlantic City, Chalfonte-Haddon Hall Hotel, June 20–24.

Massachusetts Institute of Technology will conduct its fourth Special Summer Program in Scientific and Engineering Reports, from June 20 to 24.

A NEW ORGANIZATION — the Fluid Power Society — has been formed to bring together all persons interested or engaged in any activity which may further the development and use of fluid power. Its formation is a result of collaboration over the past year between the National Fluid Power Association and the Industrial Hydraulics Training Association. Executive vice-president is Barrett Rogers, National Fluid Power Association, 5595 North Hollywood Avenue, Milwaukee 17, Wis.



CUPRO NICKEL salt water circulating line sections to serve auxiliary condensers aboard gypsum rock carriers recently fabricated by Boro Marine & Industrial Corp.

Wide variety of Cupro Nickel piping for salt water lines is readily made from sheet by welding

Circumferential joints are welded manually. Longitudinal seams are welded in mechanized equipment by inert-gas, metal-arc processes.

Ever higher velocities in salt water lines and the growing economic importance of continuity in service, on shipboard, and also in tidewater power plants and oil refineries, are leading to increasing use of Cupro Nickel in piping.

Techniques and skills for economical fabrication of even the most complicated elements of Cupro Nickel piping systems are keeping pace. Boro Marine & Industrial Corp., Port Richmond, Staten Island, N. Y., a specialist in the field, forms piping in sizes 6" to 24" diameter from Anaconda Cupro Nickel stock sheet, usually 48" x 96" x 3/16". Elements shown above indicate the variety possible. Seamless tubing is used for smaller diameters.

Boro Marine fabricates piping from both Cupro Nickel 30%-702 and Cupro Nickel 10%-755. The trend, however, is to Cupro Nickel 10%-755 for the majority of salt water line installations on commercial vessels and in industrial jobs, according to M. E. Wuensch, president. The alloy was developed by Anaconda for this kind of service. It is resistant to corrosion by both clean and polluted sea water, even at relatively high velocity of flow, and is resistant to corrosion by sea water containing air bubbles.

TECHNICAL ASSISTANCE. For help in selecting the alloy best suited for a particular job in heat transfer and piping systems, call in your American Brass representative, or write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA®

CUPRO NICKEL MILL PRODUCTS

Made by The American Brass Company

For more data circle 503 on Post Card

WHAT THEY TELL US

▶ **CHECKING BACK** through past issues of POWER ENGINEERING for information that will help with a specific problem, does pay off. The other day, Reader W. R. Parsons wrote from South Charleston, W. Va.:

> We have just recently reviewed an article (by M. S. Hartley) printed in POWER ENGINEERING in October, 1955, and find that the equipment described may have application to a particularly tough machining problem we have encountered. This application involves a machining operation inside a blind round hole in a metal block, which cannot be accomplished by normal turning or grinding operation. We would like to have the complete article . . . and any additional information or suggestions.

▶ **NS SAVANNAH,** world's first nuclear-powered ship, which was launched last summer, has been the subject of world-wide interest as well as a certain amount of apprehension because of the danger of radioactive contamination. On this whole subject of the international aspects of nuclear propulsion, Andrew W. Kramer, editor of ATOMICS, comments:

> The technical problems which had to be solved in the design and construction of the NS *Savannah* have been relatively easy compared to the international problems concerning marine biology, protection of the public from radiation hazards, indemnity in case of possible nuclear damage, and limitation of liability.
>
> Solution of these international problems has involved a tremendous amount of study and discussion with foreign authorities in an endeavor to work out rules and regulations whereby the NS *Savannah* may be permitted to enter foreign ports. The question of insurance for nuclear ships, for example, remains to be solved, not necessarily with respect to indemnity covering nuclear damage to the ships themselves but rather the question of third-party liability.
>
> In the case of land-based nuclear power plants the third-party liability has been taken care of by the Price-Anderson Amendment to the Atomic Energy Act of 1954, which provides a maximum government indemnity of $500,000,000 per nuclear incident. Since it was evident that no international agreements on the insurance problem could be reached before the NS *Savannah* goes into commercial service, the Congress of the United States amended the Price-Anderson legislation so that it covers the NS *Savannah*.
>
> This question of indemnity and third-party liability has been the subject of a number of meetings of international organizations, such as Euratom, The International Atomic Energy Agency (IAEA), the Organization for European Economic Cooperation (OEEC), the International Maritime Committee (CMI), and others. These organizations have formulated Conventions concerning the operation of nuclear ships, and these Conventions will be considered at length at the Meeting for Safety of Life at Sea which will be held in London this month.
>
> In the meantime informal and formal meetings have been held with various European nations, particularly with the United Kingdom, concerning operations of the NS *Savannah* in foreign ports. Between the UK and the US an agreement has been reached concerning the operation of the NS *Savannah* in British ports, and it is expected that the British Parliament will act upon this agreement before the NS *Savannah* makes her first visit to Great Britain in the summer of 1961.
>
> An extensive Hazard Safeguards Report has been made concerning the safety features of the NS *Savannah* and its operation, covering nine volumes. This report will be made available to all countries so that the various national authorities can evaluate the safety features of the NS *Savannah* in advance of her visits.

▶ **PENNSYLVANIA STATE UNIVERSITY** is helping the U. S. Department of Commerce answer technical inquiries from foreign countries. One of these has been relayed to us. It comes from Yugoslavia and involves insulation thickness:

> A lecturer at the agriculture faculty in Zemum, Yugoslavia, is working on the application of low temperatures in agriculture, particular attention being given to the properties of the insulating materials used, especially in connection with the determination of economic thickness of insulation materials.
>
> Information is desired on how the economical thickness of insulation is determined, taking into consideration the price of the insulation, installation cost, cost of the refrigeration plant, price of the equipment, price of the electrical energy and the operating time during the year.
>
> Currently many refrigerating plants are under construction in Yugoslavia but no attention has been given to the economic and technical points of view on the question of insulation.

There's a very good chapter on the whole subject of insulation for refrigeration equipment in the 1959 issue of the Heating Ventilation Air Conditioning Guide published by the American Society of Heating and Air Conditioning Engineers. Chapter 5 in that guide shows a table on page 48 from which economical insulation for flat surfaces can be calculated.

▶ **ON THIS PAGE** in the January, 1960, issue, Reader W. Cronin of Dublin, Ireland, expressed some views about turbine construction and the Memphis turbine repair job that we described last September. Now Mr. Cronin has a problem and would like some comments on it. He says:

> We have the problem of stopping growth of mussels in circulating water culverts, and passages, and you recently sent me a copy of an article from *Power Plant Engineering*, now POWER ENGINEERING, entitled, How to Control Marine Growth in Circulating Water Systems. I have read this with much interest.
>
> Our experience is that chlorine treatment will control mussel growth but will not entirely prevent them from developing, and that culvert cleaning once per year is necessary. Also, in the case of long culverts it can be an expensive treatment.
>
> We are therefore interested in two other methods: 1., the introduction of copper sulphite by electrolysis; and 2., ultrasonic methods.

If readers have had any experience with these two methods, they can help Mr. Cronin and us very much by giving us some of the details. Also, how about the other methods such as chlorination, steaming, and so on?

▶ **READER** L. C. Skinner of Tulsa writes:

> I am attempting to locate information regarding losses resulting from leaking or improperly set relief valves. Do your records indicate that articles on this subject have been published in your magazine? I would appreciate any references you may be able to furnish on this subject.

On this one, we need reinforcements. Can any reader, or manufacturer of relief valves, help Mr. Skinner? Write this department — and thanks.

Some Straight Talk On Steam Trap Capacity

...or pulling away the curtain of confusion that surrounds steam trap capacity ratings.

Unfortunately, for the steam trap buyer, the subject of steam trap capacity has become cloudy and confused by a landslide of claims, counter-claims and inconsistent "standards" for measurement. So let's take a cold hard look at this subject so vital to the efficient operation of your plant.

What Determines Steam Trap Capacity?

There are three factors that determine the capacity of a steam trap:

1. The area of the orifice.
2. The density of the condensate.
3. The pressure differential across the trap.

Let's take a closer look at each of these:

Area of orifice is usually specified by the trap manufacturer or can be calculated from the diameter. Nothing complicated here.

Density of condensate depends on temperature. A cubic foot of cold water weighs 62.4 lbs. At 250° F. or 15 psi, it weighs less than 59 lbs. This is important. Don't overlook it.

Pressure differential across the trap is most significant. And it is complicated by the many factors that affect it, such as:

1. Pressure drop between unit drained and the trap when the trap valve is open.
2. Distance the trap valve is moved from the valve seat.
3. Back pressure on the trap with orifice closed; i.e., return header pressure.
4. Increase in back pressure produced by condensate and flash steam flowing in the discharge line. This in turn is affected by the diameter and length of the discharge line, plus friction caused by valves and fittings.

Orifice Capacity Vs. Steam Trap Capacity

Figure 1 shows a ½" diameter sharp-edged orifice at the end of a pipe filled with cold water at 15 lbs. pressure. The capacity of this orifice, using a .61 coefficient of flow would be 8,800 lbs. per hr. Now, would this ½" orifice if used in a ¾" steam trap installed as shown in Figure 2 provide the trap with a continuous discharge capacity of 8,800 lbs. of hot condensate per hour? The answer is "no". And here are some of the reasons why:

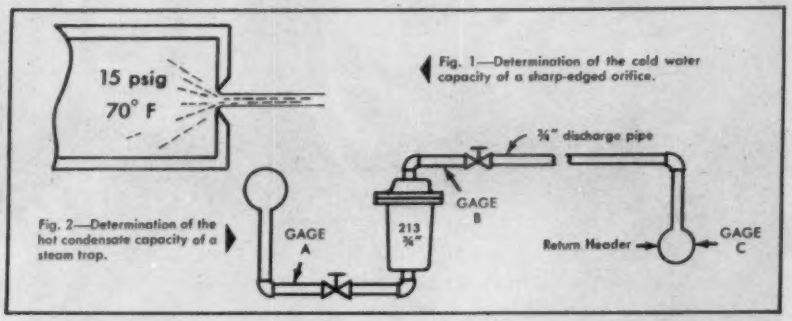


Fig. 1—Determination of the cold water capacity of a sharp-edged orifice.

Fig. 2—Determination of the hot condensate capacity of a steam trap.

Density of condensate. As pointed out above, cold water weighs 62.4 lbs. per cu. ft. At 15 lbs. pressure and 250° F. water weighs less than 59 lbs. per cu. ft. This difference in density alone reduces the lbs. per hour capacity of the orifice by over 5%.

Pressure differential across the trap. With the trap valve closed we have a static pressure differential of 15 psi. The trap valve must be able to open against this pressure. However, this is not the pressure differential that will determine the capacity of the trap valve.

The ¾" discharge line will be full of a mixture of flash steam and condensate. To keep this mixture flowing from the trap outlet to the return line requires a pressure differential. In actual capacity tests run as shown in Figure 2 Gage B at the trap outlet registered 11 lbs. back pressure. Thus the true pressure differential across the trap was about 4 lbs. Under these conditions the measured capacity of the trap was 4,340 lbs/hr. or just about half of the capacity of the ½" orifice for cold water.

How Armstrong Determines Capacity Ratings

Armstrong trap capacity ratings are based on hundreds of tests under actual operating conditions. In these tests, the condensate used was at the steam temperature corresponding to the test pressure. Thus, the capacities determined take into account the pressure drop that occurs when the trap orifice opens and the choking effect and back pressure of the flash steam. Actual installation hook-ups were used so that pipe friction in both inlet and discharge lines as well was reflected in the results.

Let's go back to the example cited above and in Figure 2. The trap referred to is an Armstrong No. 213. While it did test out at 4,340 lbs. per hour for a static pressure differential of 15 psi, it is rated in the catalog at only 3900 lbs. per hour for this pressure—just to be on the safe side.

For the trap buyer, this means that Armstrong Steam Trap capacities are based on handling condensate at steam temperature for the stated static steam pressure differential under actual working conditions.

Capacity ratings which don't take into account all of the variables will be misleading and may lead to the selection of undersized traps. So whenever you specify or buy traps be sure that the capacity ratings you work from are realistic. One way to be sure is to select Armstrong Traps with *guaranteed* capacity ratings.

* * *

Additional information on trap capacity ratings, plus data on how to correctly size, install and maintain steam traps for any pressure, any temperature and any load, are presented in the 48-page Armstrong Steam Trap Book. Ask your local Armstrong Representative for a copy or write:

Armstrong Machine Works
8108 Maple Street
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

"See our catalog in Sweet's Plant Engineering File"

For more data circle 504 on Post Card

HERE'S WHY

EASY-GRIP, VENTILATED HANDWHEEL

ACCESSIBILITY—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.

GUIDED VALVE STEM OF #321 STAINLESS STEEL
—will not "pit."
Self-aligning, stellite-faced disc.

HIGH TEMPERATURE INHIBITED STEM PACKING
—furnishes double insurance against packing leaks.

ONE-PIECE FORGED CHROME-MOLY STEEL BODY AND YOKE

EASY FLOW BODY
Smooth inner contours, reduced pressure drop.

UNIQUE SEAT DESIGN
Thermal compensating groove prevents distortion during assembly welding and when welding valve into line, permits perfect seating of disc for positive seal. Integral seat is stellite-faced.

YARWAY WELBONDS® ARE SPECIFIED FOR HIGH PRESSURE/HIGH TEMPERATURE VALVE JOBS

WELBOND VALVES—designed specifically to provide better, longer maintenance-free service in high pressure/high temperature power plants—have won resounding acceptance from operators of modern steam plants everywhere. Welbond performance speaks for itself.

Why do Yarway WELBOND valves give these results? Because only WELBOND combines all these valve advantages:

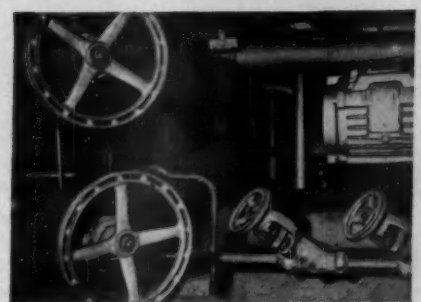
- ✓ Valve stem of 321 austenitic stainless steel prevents pitting. As an added precaution special inhibited packing gives still greater assurance against stem corrosion.
- ✓ Quick *accessibility* of all working parts through top of yoke.
- ✓ Unique seat design with thermal compensating groove provides non-distorting seat, assuring drop tight shut-off. Reseating tools available for quick "on the job" repairs to valve seat.
- ✓ One-piece forged chrome-moly steel body and yoke.
- ✓ Easy-grip, ventilated handwheel.
- ✓ Smooth inner contours, reduced pressure drop.

Yarway WELBOND valves are "proving their mettle" on high pressure boilers in all general services requiring small valves (¼" through 2½").

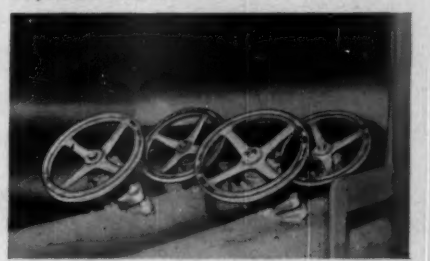
Try WELBONDS in *your* plant. Write for free Yarway Bulletin B-454.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING



● Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.



● Four of numerous Yarway Welbonds in station of large mid-west utility. These Welbonds installed on header drains.

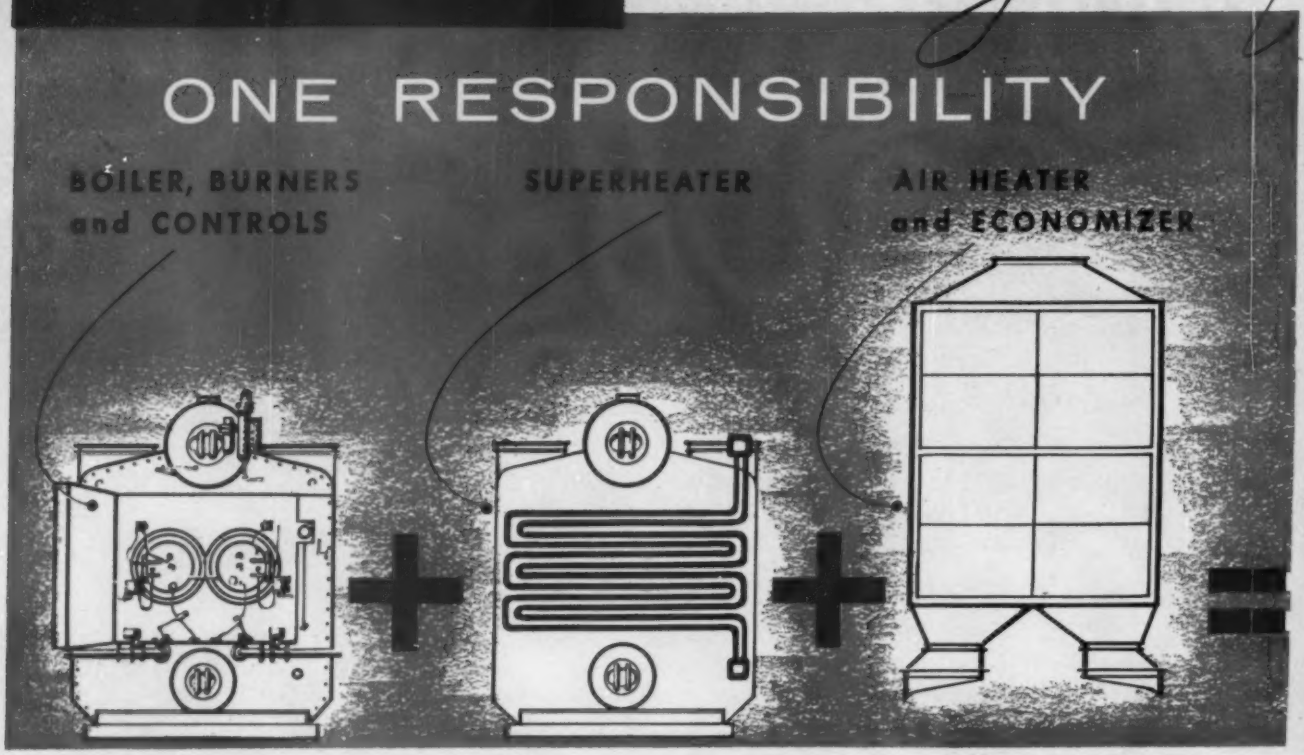
● Four Yarway Welbonds on main steam line to turbine at southern power plant. Pressure 2310 psi; temperature 1000°F. Over 100 Welbonds in plant.

● Six of more than 900 Yarway Welbonds installed in various power plants of southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

For more data circle 505 on Post Card

KEYSTONE *Package*

ONE RESPONSIBILITY

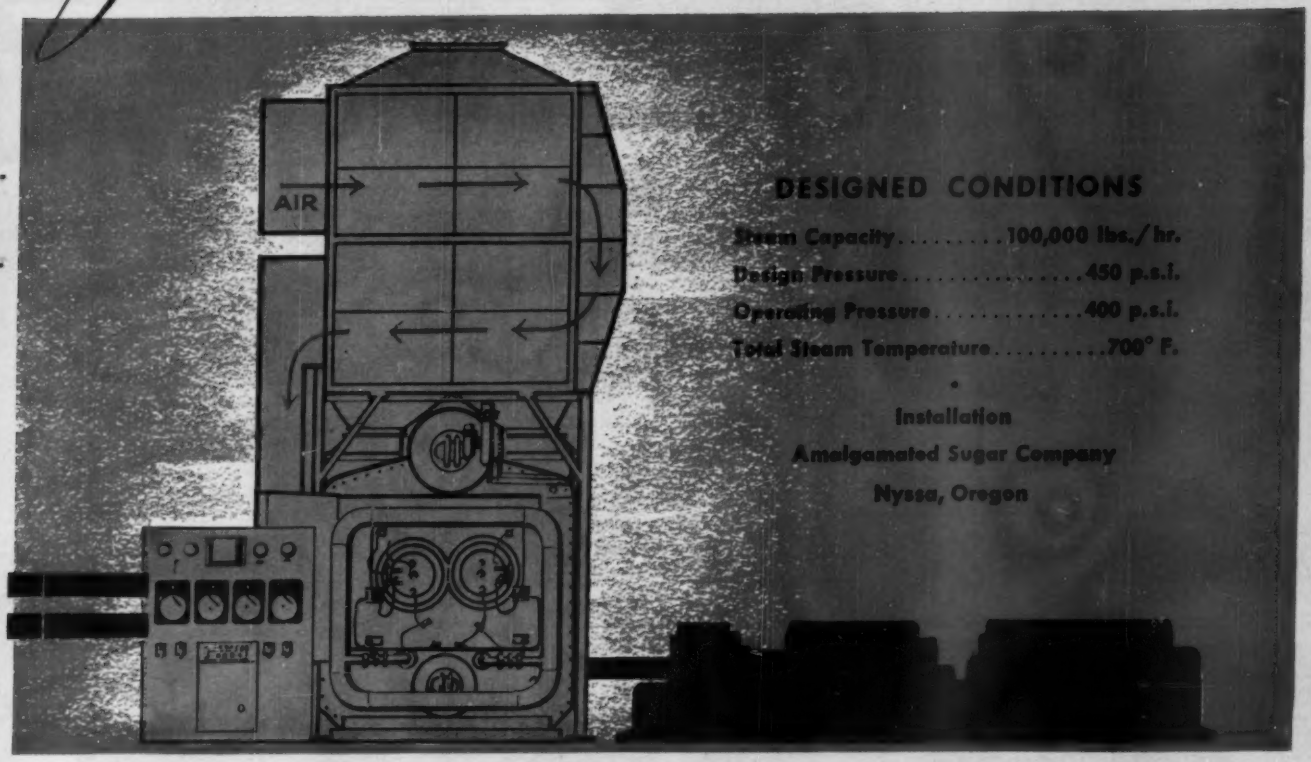


"Some of the best liked features of our KEYSTONE Steam Generator"

Amalgamated Sugar Company
Nyssa, Oregon

- **Ease of installation**
- **The large turn-down ratio of the gas burners**
- **Fast response to steam demands**
- **Minimum space for maximum capacity**
- **Minimum of attention required for operation**
- **High over-all efficiency of unit**

for Power Generation



Low Capital Investment

HERE ARE the power plant components normally associated with large field erected steam generators. These are packaged in a low cost, highly efficient installation. The boiler utilizes an integral Drainable Superheater to produce high temperature steam for use in a generating turbine. The Air Heater preheats the combustion air to provide efficiencies equal to utility standards.

Low first cost of this packaged installation saves considerable money over the cost of a similar field erected unit with no decrease in quality or efficiency.

If your problem is one of adding high pressure and high temperature steam for process work, power generation, or at low capital expenditure, to assist your present boilers during peak loads, then investigate Power Packages by Erie City Iron Works. Write for additional information in Bulletin SB-5902-E.

You can depend on ERIE CITY Since 1840 *for sound engineering*

ERIE CITY IRON WORKS · Erie, Pa.

STEAM GENERATORS • SUPERHEATERS • STOKERS • PULVERIZERS
ECONOMIZERS • WASTE HEAT BOILERS • OIL and GAS BURNERS
AIR PREHEATERS • FIRE and WATER TUBE PACKAGE BOILERS

For more data circle 506 on Post Card

See why ALCOA ALUMINUM makes a good design habit

Requirement: Low-cost, corrosion-resistant heat exchanger material
Key to Good Design: Specify Alcoa Aluminum Tube and Sheet

If corrosion resistance, long life, product purity and economy are considerations in your heat exchanger application, specify aluminum! ALCOA® Aluminum has been solving such problems for over 40 years.

In the petroleum industry, ALCOA Aluminum Tubes serve in main column overhead condensers where their freedom from fouling and excellent heat transfer properties have made them a natural selection. Heat exchangers made of ALCOA Aluminum Tube and Plate are used in the production of ammonia, nitric acid, vegetable oils, naval stores, naphthalene, hydrogen peroxide, oxygen and urea. These and other processes call for heat exchangers with combinations of high strength, excellent sub-zero physical qualities, high thermal conductivity, or nontoxic and noncatalytic properties. ALCOA Aluminum alloys meet all these requirements.

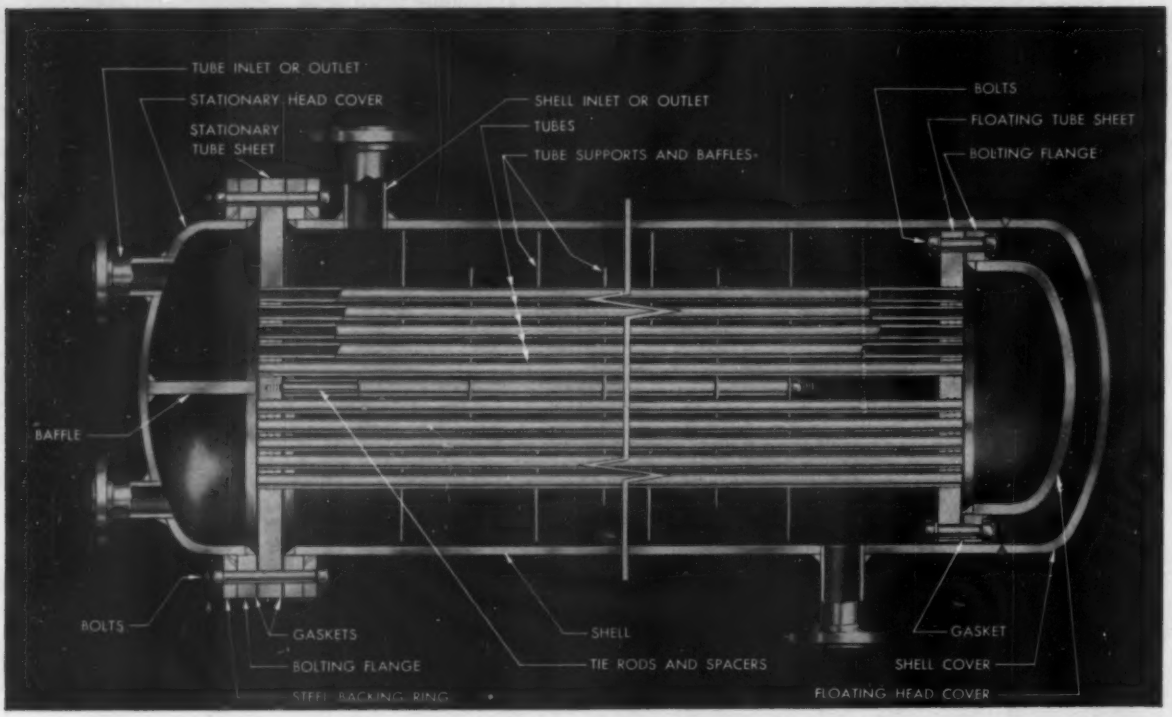
As for cost, ALCOA Aluminum Tube is the most inexpensive. In the common sizes it costs one-third less than mild steel, one-half as much as admiralty, and one-fifth that of stainless.

ALCOA Aluminum alloys are ideally suited to a wide range of maintenance methods. For relatively soft or loose scale, water jets and brushes are usually satisfactory. Wet sandblasting as well as chemical cleaners may be used effectively.

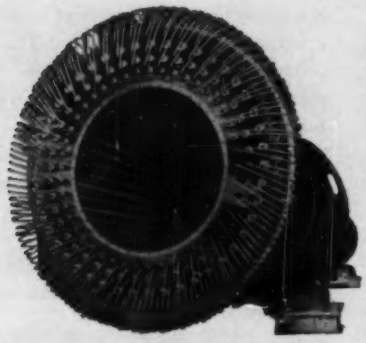
ALCOA engineers have worked closely with all segments of the process industries for over 40 years, and can help you specify the aluminum alloy best suited to your heat exchanger and other process applications. ALCOA's unparalleled experience in this field is available to you for the asking. Write to the address on the coupon, stating your requirements as specifically as possible. ALCOA's development engineers will welcome the opportunity to work with you on your problems.

You can also take advantage of the wide selection of free ALCOA literature on aluminum for heat exchangers and other process applications. Simply check the booklets you want on the coupon and mail to the address indicated. ALCOA will forward your material promptly and without obligation.

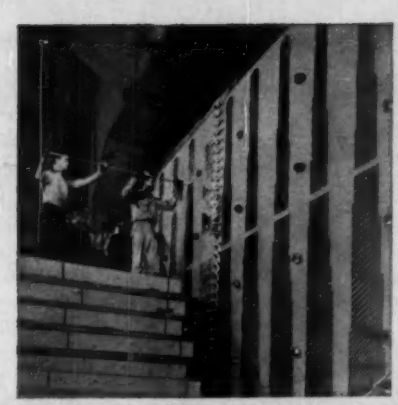
ALCOA is conducting a series of engineering conferences on process industries applications of aluminum during 1960 in a number of major cities. Contact your nearest ALCOA sales office for full particulars and dates.



For certain processes where corrosive or sensitive materials are involved, it is often advisable to use aluminum for entire heat exchanger systems to avoid system corrosion and contamination of the product. A typical all-aluminum heat exchanger is shown here. Alloy recommendations are given in the table opposite.

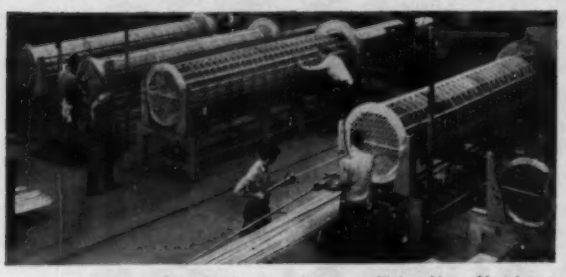


Alcoa Aluminum Tubing protects color in the world's largest rotary steam-tube drier. The drier measures 10 ft in diameter by 100 ft long.

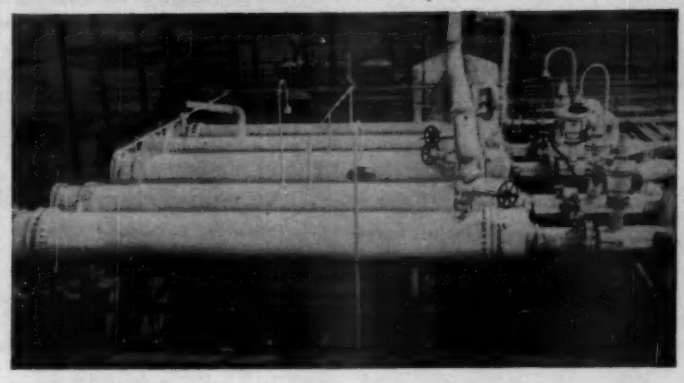


A Midwest utility saved 50 per cent on tubing costs by using Alcoa Aluminum instead of admiralty for tubing in this surface condenser. Successful operation of this unit has led to the installation of similar units by other utilities. This use demonstrates aluminum's economy and superior resistance to ammonia, carbon dioxide and hydrogen sulfide.

A battery of all-aluminum heat exchangers in a polyethylene plant. Selected for initial low cost, these aluminum exchangers provide freedom from product contamination as well as desirable low temperature properties.



Construction of a heat exchanger utilizing Alcoa Aluminum Tube. Superior working properties plus the cold-drawing method by which Alcoa seamless heat exchanger tubes are produced results in close dimensional tolerances and smooth inside and outside surfaces.

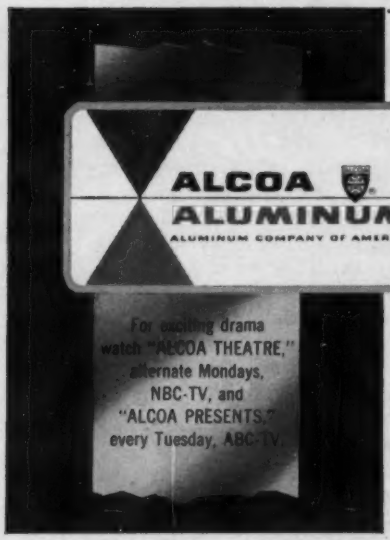


This all-aluminum dephlegmator in a large coke plant is used for the regeneration of ammonia liquor in a hydrogen sulfide scrubbing operation. Aluminum tubes lasted five times longer than steel tubes in a similar use.

Alloy Recommendations for Aluminum Heat Exchanger Construction

	Alcoa Designation		ASTM Specification*	Alloy
Tubes		3003-H14	B234	M1A
	Alclad (inside)	3003-H14	B234	clad M1A
	Alclad (outside)	3003-H14		clad M1A
	Alclad (both sides)	3003-H14		clad M1A
		6061-T6	B234	GS11A
		6062-T6	B234	GS11C
Tube Sheets		3004-H112	B178	MG11A
	Alclad	3004-H112	B178	clad MG11A
		6061-T6	B178	GS11A
	Alclad	6061-T6	B178	clad GS11A
Baffles		3003-H14	B178	M1A
	Alclad	3003-H14	B178	clad M1A
Tie Rods		6061-T6	B273	GS11A
Shells & Headers		3003-H112	B178	M1A
	Alclad	3003-H112	B178	clad M1A
		3004-H112	B178	MG11A
		5052-H112	B178	GR20A
		5154-H112	B178	GR40A
Fittings		3003-F	B274	M1A as applicable
		6061-T6	B274	GS11A as applicable
Flanges		6061-T6	B247	GS11A as applicable

*Only the basic number is shown since Alcoa products are manufactured to the latest issue of the specification. The complete number would indicate the year of issue.


ALCOA
ALUMINUM
ALUMINUM COMPANY OF AMERICA
For exciting drama watch "ALCOA THEATRE," alternate Mondays, NBC-TV, and "ALCOA PRESENTS," every Tuesday, ABC-TV.

Aluminum Company of America
876-E Alcoa Building, Pittsburgh 19, Pa.

Please send me the following literature covering Alcoa Aluminum in heat exchanger and other applications in the process industries.

- ☐ 10186 Alcoa Aluminum Heat Exchanger Tubes
- ☐ 20437 Aluminum Alloy Heat Exchangers in the Process Industries
- ☐ 10460 Process Industries Applications of Alcoa Aluminum
- ☐ 20849 Resistance of Aluminum Alloys to Weathering and Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres
- ☐ 20272 Aluminum Alloys for Handling High Purity Water
- ☐ 20268 Resistance of Aluminum Alloys to Fresh Waters
- ☐ 20935 Designing to Prevent Corrosion

Name_____

Company_____

Title_____

Address_____

City_____

State_____

For more data circle 507 on Post Card

HELPFUL WATER CONDITIONING DATA FROM BETZ

CORROSION CONTROL FOR

The modern tools of corrosion control can reduce repair and maintenance costs in your boiler plant.

Corrosion in the modern boiler plant can manifest itself in many locations; such as in the pre-boiler equipment, in the boilers and in the steam and condensate systems. Figures 1, 2 and 3 are typical illustrations of the damage done at some of these locations.

For the most part corrosion is due to dissolved oxygen. Other factors such as low pH values, carbon dioxide and ammonia may be involved, either alone or in conjunction with dissolved oxygen. The preventive measures required to adequately control corrosion involve mechanical equipment and/or chemical treatment.

Mechanical Deaeration

The first line of defense in preventing corrosion is mechanical deaeration. As applied to boiler feedwater, this involves removal of dissolved oxygen in a vented heater by intimately mixing, scrubbing and heating the water with steam. The feedwater heater removes dissolved oxygen, decreases free carbon dioxide and elevates the feedwater to the saturation temperature of the steam. Since exhaust steam is used whenever available, boiler efficiency is also improved. Complex heater designs are required to secure maximum mechanical deaeration. The types of heaters employed include:

1. The *conventional open heater* is most frequently employed in the low pressure boiler plant and is designed to decrease dissolved oxygen to a range of 0.1-0.3 cc per liter.
2. The *deaerating heater* is a unit designed to decrease dissolved oxygen to concentrations of 0.03 cc per liter.
3. The *deaerator* is a unit designed to decrease dissolved oxygen to 0.005 cc per liter or less.

In plants that use simple receivers or open tanks in place of specially designed feedwater heaters, substantial amounts of dissolved oxygen will remain in the feedwater. For example, at atmospheric pressure and temperatures of 120 F, 150 F and 180 F, residual dissolved oxygen concentrations expected are 5.7, 4.3 and 1.5 ppm respectively. It is important therefore to maintain the feedwater temperature as high as possible for maximum removal of dissolved oxygen. The supplemental use of a chemical deaerant is essential in these plants to control corrosion and pitting due to dissolved oxygen. A second essential requirement is that the feedwater temperature be maintained at a consistently high level. Wide fluctuations in feedwater temperature would make it difficult, if not impossible, to regulate the feed of the chemical deaerant to cope with the varying concentrations of residual oxygen.

Figure 1—Pitting in boiler drum.

Chemical Deaeration

Sodium sulfite is the chemical agent favored for chemical deaeration in all but the high pressure plants because of its low cost and ease of handling. Where speed of reaction is important a catalyzed sodium sulfite is available which will react instantaneously with dissolved oxygen. The reaction of sodium sulfite with dissolved oxygen is illustrated as follows:

$$2Na_2SO_3 + O_2 = 2Na_2SO_4$$

sodium sulfite + oxygen = sodium sulfate

To remove 1.0 ppm of dissolved oxygen approximately 10 ppm of technical grade sodium sulfite is required. The end product is sodium sulfate which adds to the dissolved solids content of the water, but is otherwise innocuous.

While chemical deaeration is essential where incomplete mechanical deaeration of the feedwater is accomplished, it is a much desired supplement even when employing specially designed feedwater heaters. The low additional cost of the chemical deaerant in these cases is justified as it provides:

1. Complete oxygen removal.
2. An added safety factor in the event of momentary interruptions in efficiency of mechanical deaeration.
3. Warning when the efficiency of mechanical deaeration is continuously low.
4. Protection of the pre-boiler equipment, such as feed pumps, feedlines, stage heaters and economizers.

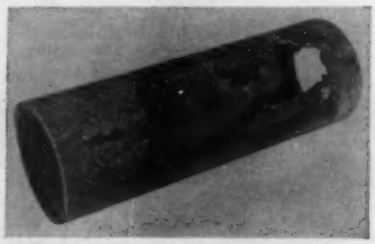


Figure 2—Condensate line attack by carbon dioxide.

In many plants, the most suitable point of application is the storage compartment of the feedwater heater. In other plants, sufficient reaction time may be available with continuous feed to the suction side of the boiler feed pump.

As boiler operating pressures have increased, two disadvantages of sodium sulfite as a chemical deaerant have become evident. While the increase in dissolved solids produced by the end product sodium sulfate is of little consequence in low or medium pressure boilers, it can be of significance in high pressure boilers. Also, at high pressures, the residual sulfite required for control

purposes, tends to decompose to form the acidic gases, sulfur dioxide and hydrogen sulfide which can contribute to corrosion in the steam and condensate systems. For these reasons, hydrazine finds favor as a chemical deaerant in high pressure boiler systems. Hydrazine removes dissolved oxygen in accordance with the following reaction:

$$N_2H_4 + O_2 = 2H_2O + N_2$$
hydrazine + oxygen = water + nitrogen

Since the products of this reaction are water and nitrogen no dissolved solids are added to the boiler water. In addition, the decomposition products of the residual hydrazine are ammonia and nitrogen. The ammonia is alkaline and will not attack steel. However, it is essential to avoid high residuals of hydrazine otherwise the ammonia produced may have an adverse effect on copper and copper bearing alloys.

Except for special cases of corrosive attack involving high pressure boiler operation, experience has shown that it is desirable to maintain a minimum boiler water pH of approximately 10.5. This pH is sufficiently high to prevent corrosion of the boiler proper. Usually, in the low and moderate pressure range, boiler water alkalinity is set at sufficiently high levels primarily to assure the proper environment for precipitation of calcium and magnesium sludge. These levels assure at least the minimum pH necessary for proper protection of the boiler against acidic corrosion.

In high pressure boilers the alkalinity level is restricted to avoid "free caustic" and thus prevent embrittlement and other adverse effects.

Carbon dioxide has little bearing on corrosion of the pre-boiler system or the boiler proper. Efficient mechanical deaeration will decrease the free carbon dioxide of the boiler feedwater and as a result the pH of the feedwater will increase. The increase in pH thus produced together with the feed of a chemical deaerant usually affords adequate protection to the pre-boiler system. In some cases, the supplemental feed of caustic soda may be employed to further increase the pH of the feedwater and to speed the reaction of the chemical deaerant.

The concern with carbon dioxide is primarily due to its adverse effect in the steam and condensate system. The natural bicarbonate alkalinity of the feedwater decomposes when subjected to boiler temperature, yielding carbon dioxide which leaves the boiler with the steam. At points of condensation low pH will develop from the carbonic acid formed and corrosion will ensue. Prevention of steam and condensate corrosion can effectively and economically be accomplished by use of the film forming or neutralizing amines.

Protection of Idle Equipment

All too often, little attention is given to idle equipment in the boiler plant until serious corrosion has developed. Special measures are necessary to protect idle boilers and steam turbines. The methods applicable depend on many factors but suitable procedures can be worked out for most conditions.

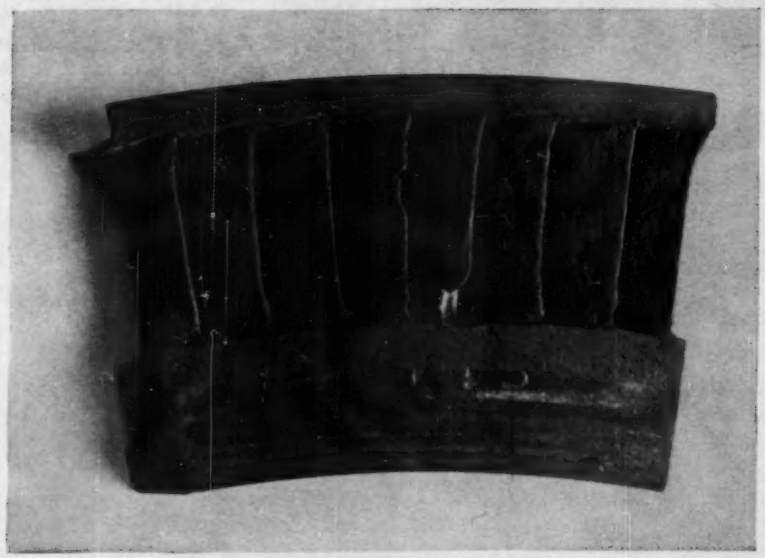


Figure 3—Corrosion of turbine blades.

Other Factors

While mechanical and chemical deaeration will serve to cope with dissolved oxygen—the major cause of corrosion in boiler plants—pH and carbon dioxide are factors that must also be considered.

Betz Laboratories has pioneered in the development and practical application of many boiler corrosion prevention techniques. With an extensive background of experience in this field, we are ready to help solve your particular problem effectively and economically. A Betz Field Engineer will be happy to call on you, without obligation.

BETZ LABORATORIES, INC.
Gillingham & Worth Streets • Phila. 24, Pa.

BETZ

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

For more data circle 508 on Post Card

The Story of Edward Research

and the Pressure-Seal* Valve

The introduction, in 1945, of commercial steel valves with pressure-seal bonnet joint construction was a significant advance in the art of building large high-pressure steel valves. The new pressure-seal construction eliminated massive flanged bonnet joint connections and made it possible to seal the valves permanently at high temperature. These advantages were immediately apparent to users everywhere. But bonnet joint leakage problems developed on the new valves in service. And Edward engineers soon became convinced that the original 45° pressure-seal gasket design used by Edward and others required improvement. Here's the Edward pressure-seal redesign story:

INITIAL TESTING—Edward engineers began their studies on leak problems in 45° gasketed pressure-seal valves by determining under what conditions the valves were most likely to leak. It was discovered that when sealing areas were thoroughly degreased and tested with air, the pressure seal would leak at all pressures above 10 psi. In addition, minute imperfections in the sealing area of the valve body bore were preventing intimate gasket contact and contributing to leakage. Edward engineers found that a broader area of contact between gasket and bonnet and between gasket and body bore would also reduce leakage. Further investigation showed that a gasket plating material softer than the silver plating previously used would be helpful in achieving better contact in the sealing area.

To obtain more gasket sealing area, experiments were conducted on gaskets with angles from 45° down to 17°. Over a period of several months, tests were made with 25 different combinations of gasket and bonnet angles and various gasket plating materials. Assembled valves were tested for tightness with air pressures ranging from 10 psi to 2160 psi, and at temperatures up to 1000 F for extended periods. And tests on ease of valve disassembly (an important user consideration) were made with each gasket combination.

TEST CONCLUSIONS—At the end of their extensive testing program on the pressure-seal design, Edward engineers were able to draw these conclusions:

1. 45° gaskets, which showed no leak on water tests, leaked air at similar pressures.
2. No gasket of any design, either plain or with a plating of 100 Brinell or harder, would seal air when assembled unlubricated.
3. The best sealing under test resulted with a 25° gasket angle which was 1° more acute than the bonnet angle.
4. Gaskets of 25° angle actually tripled the sealing surface area.
5. A stainless inlay in the valve body bore sealing area substantially improved gasket-to-body contact and provided a corrosion-resistant surface.
6. Gaskets of 25° angle, plated properly with a malleable coating, gave perfect air or steam sealing at all temperatures, whether assembled dry or with a lubricant.

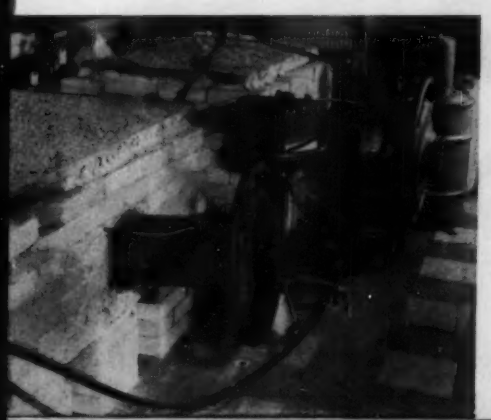
NEW VALVE DESIGN—As the result of their tests, Edward engineers designed the completely new pressure-seal valve with 25°-65° joint (see diagram below). This change in gasket angle, with an increase in sealing surface area, and the addition of a special corrosion-resistant malleable coating, brought an end to bonnet joint leakage in Edward pressure-seal valves. And, since 1953, thousands of Edward pressure-seal valves have been installed in a great variety of services *without a single case of failure reported to date.*

The story of Edward research and the pressure-seal valve is typical of the kind of research progress and product leadership you can expect from Edward Valves. Edward builds a complete line of forged and cast steel valves from ¼" to 18" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1202 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

*Patented

EDWARD STEEL VALVES
another fine product by
ROCKWELL

P. J. DUKES, product development engineer, and D. MacGregor, works manager, are shown with helium leak detector used in testing pressure-seal valve joints.



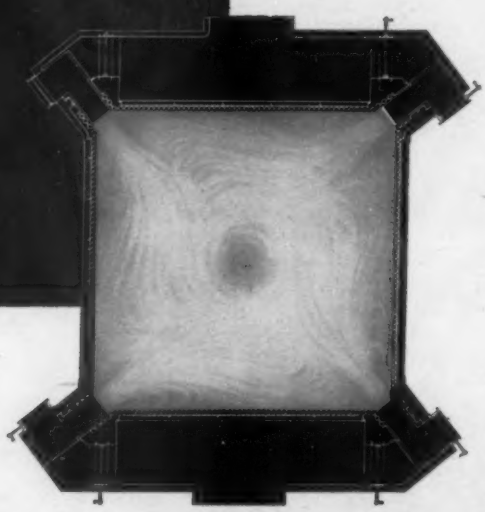
SPECIAL GAS-FIRED FURNACES were used in temperature testing of new pressure-seal valve design. Furnaces heated valves up to 900 F for 24 hour periods. Pressure was maintained with hydro-pneumatic pumps.

NEW 25° GASKET DESIGN

TANGENTIAL

Looking up into the furnace of a C-E Controlled Circulation Boiler. One of its four Tilting, Tangential Burners is being moved into position. The burner and its adjacent water wall tubes are shop assembled into a single panel and handled as one piece. All four corners of the furnace are similarly equipped. Tangential burners may be arranged to burn coal, oil or gas separately or in combination.

Sectional plan view through tangentially fired furnace showing impinging action of fuel streams from the burners which results in extreme turbulence and thorough mixing of fuel and air.



COMBUSTION

Combustion Engineering Building

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

FIRING...
best for big boilers

Tangential firing – an exclusive C-E development–was introduced by Combustion in 1927. The tilting feature of the burner nozzles, for control of superheat temperatures, was added to the basic design in the late thirties. Among the many proven advantages of the C-E Tilting, Tangential Burner, those enumerated below are especially noteworthy – whether the fuel be coal, oil or gas, or combinations thereof.

Combustion is better

1. The extreme turbulence created by impinging flame streams of adjacent burners assures the most effective mixing of all the air with all of the fuel to produce the most rapid and complete combustion. Minimum carbon loss is assured.
2. The swirling rotating travel of combustion gases fills the furnace cross-section and utilizes the heat absorbing wall surfaces most effectively.

Superheat is controlled

1. If steam temperature goes too high, the C-E Tilting Tangential Burner nozzles automatically tilt downward. More furnace wall surface becomes effective. Gas temperature to superheat surface is lowered. Steam temperature comes down.
2. Conversely, if steam temperature drops below that efficient for the turbine, nozzles tilt upward, sending hotter gases to the superheater. Steam temperature goes up – automatically.

Acceptance is widespread

About 650 tangentially fired C-E Boilers with an aggregate capacity of about 400-million pounds of steam per hour are now in service; another 85 units are under construction or on order. In 1959 alone 31 new C-E Boilers with an aggregate capacity of over 5-million kilowatts were put in operation in electric utility plants. All of these units are tangentially fired.

Thus, tangential firing has established itself in service over a period of many years as the most widely accepted method of firing for big boilers. More recently it has met similar success in smaller oil and gas fired units for capacities as low as 70,000 lbs. of steam per hour. Catalog PC 8 gives full information. May we send you a copy?

ENGINEERING

200 Madison Avenue, New York 16, N. Y.

C-E

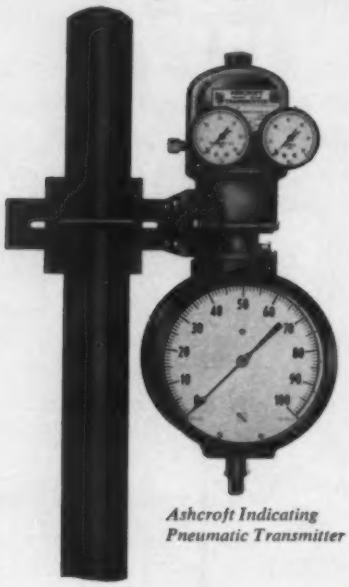
C-263

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more data circle 510 on Post Card

signal action

ASHCROFT PNEUMATIC TRANSMITTERS give you a true primary and transmitted signal for indication or control



Ashcroft Indicating Pneumatic Transmitter

Now—detect with precision accuracy the slightest change in primary pressure or temperature. Transmit this signal quickly to your indicators or controllers. Ashcroft Pneumatic Transmitters achieve these results for you at the lowest initial and operating costs.

Full-range, solid-front indicating and totally accessible nonindicating transmitters eliminate the need for costly high pressure lines, yet permit complete monitoring of process conditions in remote areas.

Narrow-span Ashcroft Transmitters are expressly designed with highest sensitivity and repeatability for the most accurate primary signal feed to controllers. You get better control and purer, lower-cost final products.

Only in Ashcroft Pneumatic Transmitters can you get the wide choice of Ashcroft Duragauge Bourdon tubes or American mercury or gas-actuated systems for sensing pressure or temperature conditions. You also get a time-proven, obstruction-proof, force-balance, nonbleed relay for economical, maintenance-free 3-15 psi or 3-27 psi signal transmission.

Write for factful Bulletins 360 and 361 or ask your nearby Ashcroft Distributor to help you select the right transmitters and receiver gauges for your specific requirements.

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

ASHCROFT PNEUMATIC TRANSMITTERS

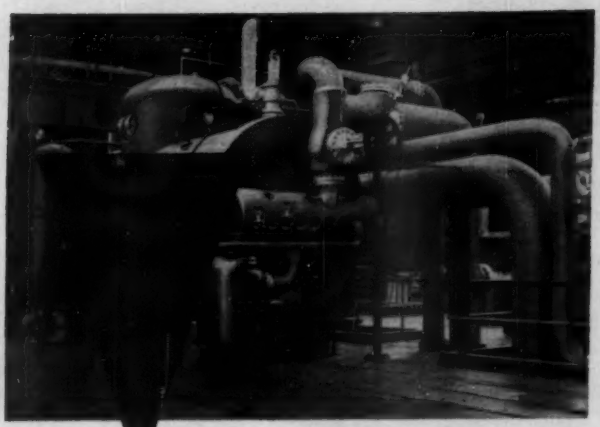
A product of

MANNING, MAXWELL & MOORE, INC.

Gauge and Instrument Division • Stratford, Connecticut

In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data circle 511 on Post Card



WHEN INDUSTRY NEEDS WATER

PURER THAN THE DRIVEN SNOW

Yuba Evaporators are achieving new record high purities

In power, processing, marine or any industry that needs high purity water in volume, Yuba evaporators are recognized as the finest equipment available today. There are good reasons why. Recent tests by Consolidated Edison Company of New York show that purities better than 0.004 PPM total solids are achieved – purities "heretofore unknown." Heart of the Yuba evaporator is the patented improved bubble tray design. Yuba evaporators have reached their present peak because of continuous refinement of design, engineering and manufacturing. And Yuba's mechanical vapor purifier has also been found to be the most efficient of its type within the limits of mechanical purifier design.

Bubble tray or mechanical evaporators, Yuba designs are the most flexible in the industry. They can be installed vertically or horizontally—in a wide capacity range – depending on the industry need or basic plant design. Whatever your high purity water need, remember Yuba for the finest in evaporators. Write today for the complete story of tests on Yuba equipment – Bulletin YHT 101.

Other Yuba products for steam power plants include Condensers, Feedwater Heaters, Expansion Joints, Heaters, Tanks, Cranes, Structural Steel and scores of other items.

YUBA

specialists in heat transfer equipment

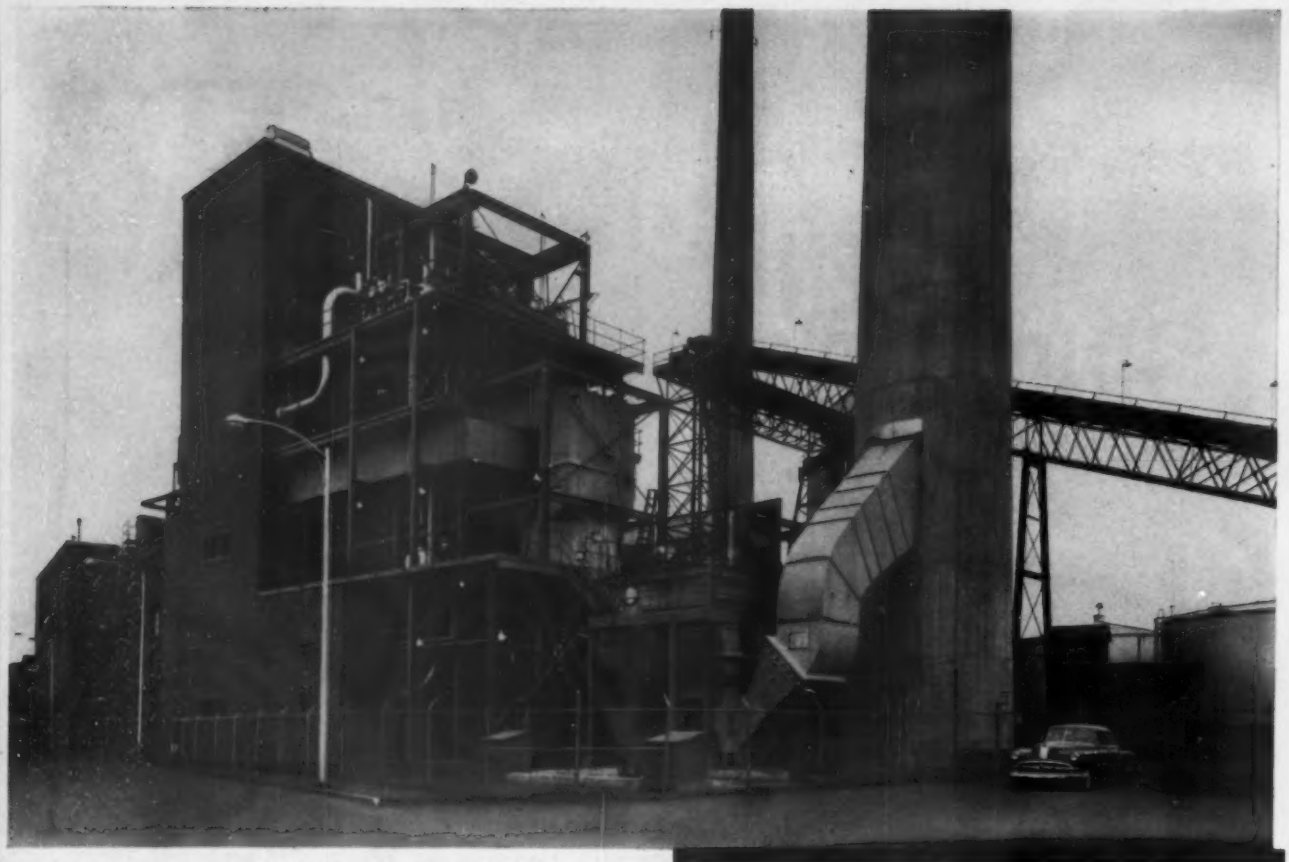
YUBA HEAT TRANSFER DIVISION

4th and Main Streets, Honesdale, Pennsylvania

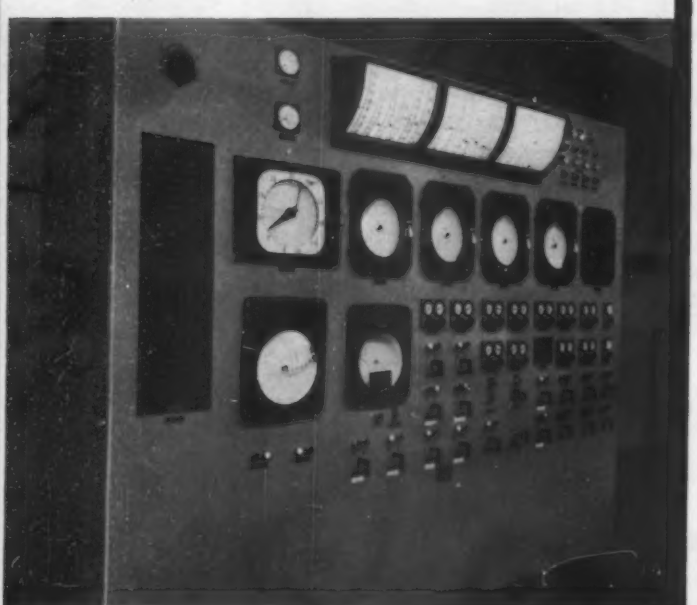
YUBA CONSOLIDATED INDUSTRIES, INC.

Sales Offices in Atlanta • Buffalo • Chicago • Cleveland • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • San Francisco • Seattle

For more data circle 512 on Post Card

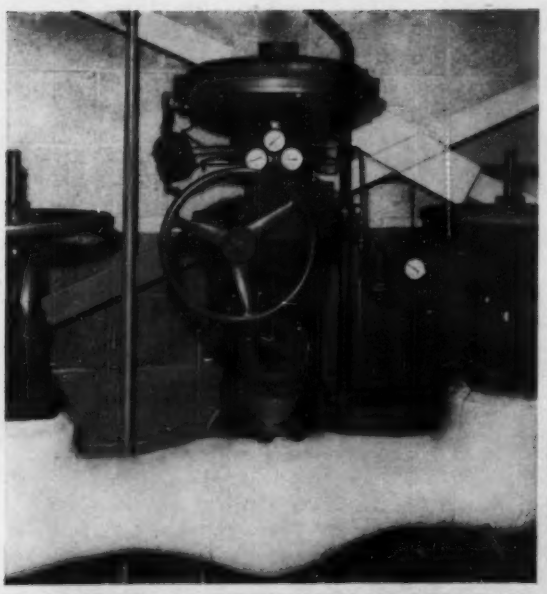


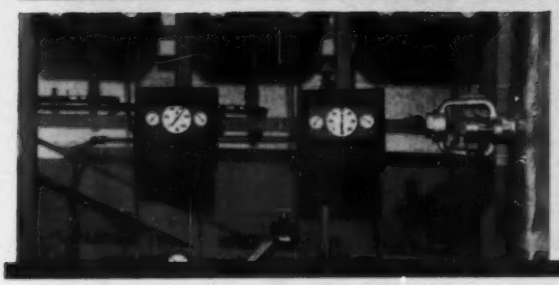
Except for the firing aisle and control room, Boiler Unit 7 is outdoors and subject to sub-zero temperatures. The unit delivers steam at 850 psig and 900°F to a 16,500-kw turbine-generator installed in the tall building (left) some 200 feet away.



Eleven miniature Copes-Vulcan stations on this operating panel provide remote control of all processes with automatic-to-manual, or manual-to-automatic selection, with "bumpless" transfer. Automatic and manual loadings can be matched perfectly without going through a seal or reset position.

Copes-Vulcan boiler control automatically balances output with demand at Taunton Plant





Diaphragm-type control valve (upper left) is used with Copes Type 3-L feedwater control. The valve features positioner, air lock, and side-mounted handwheel for emergency operation.

Designed for superior accuracy and long range dependability, Copes-Vulcan valves establish new standards of efficiency for pressure, temperature, flow, and level control.

Two versatile regulator valves are available for pressure standards from 125 through 2500 pounds. Diaphragm-type CV-D is designed for remote control service, can be direct or reverse acting, features excellent rangeability. Piston-type CV-P is designed for high-duty service, assures maximum power with precise positioning. **Write for Bulletin 1027.**

The two field mounted Copes-Vulcan indicating pressure transmitters (lower left) are used for feedwater (left) and fuel oil (right). Proportional action with pneumatic feedback is ideal for pressure-regulating service.

Copes-Vulcan transmitters feature good repeatability. Standard output pressure is 3 to 15 psi for input bands of 1 to 100%. Outputs of 6 to 30 psi and 12 to 60 psi are also available. **Write for Bulletin 1036.**

Drive unit (right) for the inlet damper of the induced-draft fan is installed at ground level outdoors. Insulation, used for protection against adverse weather, is easily removed for inspection and maintenance of the unit.

Copes-Vulcan Drive Units permit remote positioning by automatic or manual signals. They may have linear, square, or square-root characteristics, or may be field-characterized.

Five models are available. All have 90-degree angular rotation and may be manually operated by a handwheel. **Write for Bulletin 1033.**

The Municipal Lighting Plant in Taunton, Massachusetts, selected Copes-Vulcan to provide Unit 7 with precision boiler control. Featuring simplicity of circuits and dependable accurate components, the Copes-Vulcan system automatically maintains a constant main steam-header pressure under varying demands. Peak loads reach 170,000 pounds per hour. Operation remains under fully automatic control down to 40,000 pounds per hour.

Unique combustion control includes skillfully designed circuits for fuel-loading report-back and fuel cut-back. Other controls assure constant furnace pressure, the correct ratio between steam flow and air flow, and a practically constant drum water level.

Temperatures and pressures regulated. Air-heater temperature, mill pressure, and steam temperature at the superheater outlet are accurately managed.

A complete line—a complete service. In addition to boiler control, the Copes-Vulcan line includes complete systems for fully automatic soot blowing, pressure reducing, and desuperheating. All are custom engineered. All are backed by more than 50 years of design experience.

Whether your boiler be large or small, power or process, Copes-Vulcan can provide a unit or a coordinated package to meet your requirements.

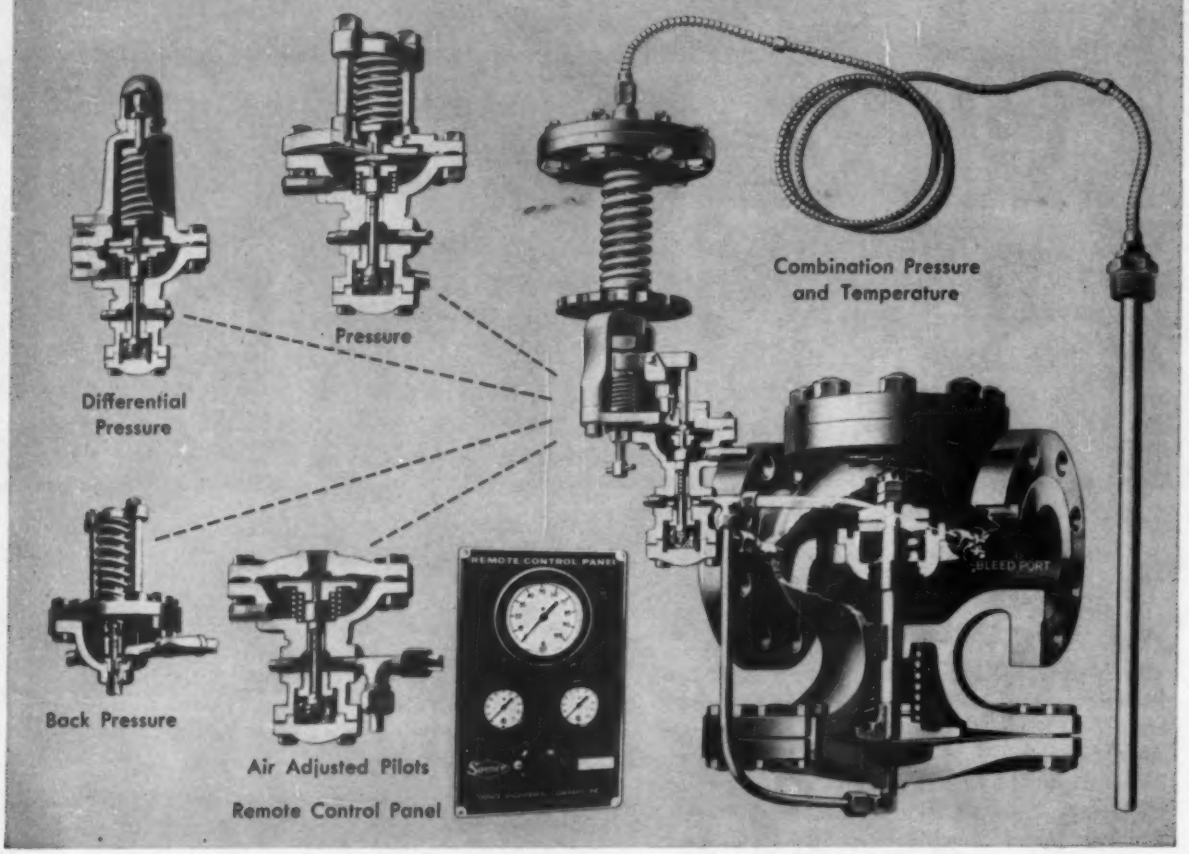
For the complete story, write for Bulletin 1065. Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

BLAW-KNOX

For more data circle 513 on Post Card

All Pilots Fit All Main Valve Sizes Downtime, Maintenance, Inventory Reduced



Let's start off by admitting there's no such thing as a "maintenance-free" regulating valve. Any valve that automatically controls temperatures or pressures within close limits can be affected by dirt in steam lines.

If trouble does develop, engineers want a regulator they can get back on the line — fast. That's one reason why more engineers are standardizing on Spence Regulating Valves with externally mounted pilots. The simple test of disconnecting the external bends establishes whether the trouble is in the main valve or the pilot.

If the main valve is the trouble spot, it can be maintained without removing the valve body from the line. If the pilot is the trouble spot, it is easily removed for cleaning. However, if production downtime is a strong factor, the fastest method is to install a spare pilot and it is inexpensive.

All Spence pilots fit all sizes of Spence main valves. If you have twenty pressure regulators, for instance, all you need is *one spare pilot*. It will fit all main valve sizes from ¼″ to 12″.

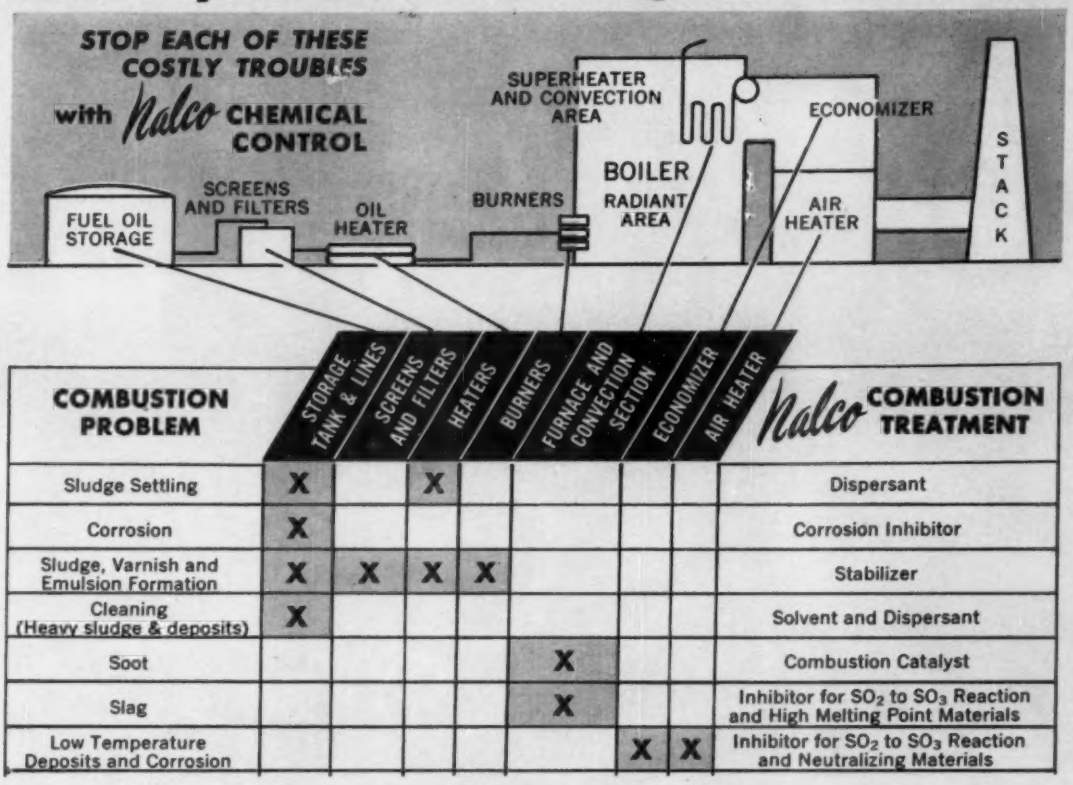
Another advantage of the Spence design is the external pilot is interchangeable. You can change the function of a regulator by merely changing the pilot. In many plants this can represent an important factor in reduced inventory costs because you only carry a few inexpensive extra pilots instead of complete regulators. Obviously, there is also a considerable savings in labor costs when a valve can be converted, in the line, from a temperature regulator to any one of various pressure regulators.

The pictures above show a few of Spence's wide line of automatic regulators. For more information write for Bulletin TE.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York SE-145

For more data circle 514 on Post Card

Nalco Residual Fuel Oil Treatments Protect Boiler Systems from Storage to Stack



COMBUSTION PROBLEM	STORAGE TANK & LINES	SCREENS AND FILTERS	HEATERS	BURNERS	FURNACE AND CONVECTION SECTION	ECONOMIZER	AIR HEATER	Nalco COMBUSTION TREATMENT
Sludge Settling	X		X					Dispersant
Corrosion	X							Corrosion Inhibitor
Sludge, Varnish and Emulsion Formation	X	X	X	X				Stabilizer
Cleaning (Heavy sludge & deposits)	X							Solvent and Dispersant
Soot					X			Combustion Catalyst
Slag					X			Inhibitor for SO_2 to SO_3 Reaction and High Melting Point Materials
Low Temperature Deposits and Corrosion						X	X	Inhibitor for SO_2 to SO_3 Reaction and Neutralizing Materials

Low-cost fuel oil will not become an expensive cause of power plant maintenance and replacement costs when you put Nalco treatments to work controlling sludge, deposits, corrosion, soot, slag or acid formation. There is a Nalco treatment for each of these specialized jobs . . . to provide you with effective protection from storage to stack.

Pre-Flame System

Storage tanks and the pre-flame fuel system can be kept deposit- and corrosion-free with Nalco sludge dispersants, corrosion inhibitors and stabilizing treatments. Where sludge deposits have built up in tanks, there are Nalco treatments that will disperse them into usable fuel and recover lost storage space. Stabilizers and dispersants assure better burning by preventing fouling of burners by varnish or sludge.

Furnace and Convection Area

Soot and slag deposits are common troubles caused by untreated residual fuel oils. There is a Nalco treatment for control of each of them . . . to substantially boost efficiency and reduce mechanical cleaning costs. Combustion catalyst type treatments lower soot ignition temperatures . . . assure more complete combustion, cleaner burning. Slag deposits are substantially reduced by additives that modify the high temperature chemical reactions of ash and sulfur in the oil.

Economizer and Air Heater Sections

Keeping corrosion and acidic deposits out of economizers and air heaters was often the most difficult part of plant combustion problems to solve economically—until Nalco developed successful "cold-end" treatments. Inhibitor-neutralizers modify the chemical reactions which convert sulfur dioxide to the sulfur trioxide that creates corrosive conditions in low temperature areas.

Long Range Economy

Residual fuel oils, *plus Nalco fuel oil treatments*, can build a very attractive operating-cost picture in your plant. For a flying start toward long-range fuel economy, call your Nalco Representative today, or write us for details on *specific* Nalco answers to your combustion problems.

NALCO CHEMICAL COMPANY
6224 West 66th Place • Chicago 38, Illinois
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada—Alchem Limited, Burlington, Ontario

Nalco® . . . **Serving Industry through Practical Applied Science**

For more data circle 515 on Post Card

CLEARWATER FINISHING
GETS SAVINGS
WITH INTEREST,
USING A

PACKAGE AIR PREHEATER

Fuel savings alone pay for it in two years; installation costs cut by pre-assembly — —

Savings come in pairs at Clearwater Finishing Co., with the installation of their new Package Air Preheater. This is why:

1. Initial savings on installation. You can install a Package Air Preheater at a fraction of the expense required for conventional heat recovery equipment. The unit you see in the picture is a *complete* Package Air Preheater. To put it into service you simply lift it into place, make power and duct connections. It's that fast, that easy.

2. Long term fuel savings . . . $17,000 a year off your fuel bill (more or less, depending on size of preheater and application). What you save on fuel can pay for the Package Air Preheater within two years.

Installation savings are achieved through standardized design, which permits complete shop assembly. Fuel savings are achieved through the efficient continuous regenerative heat recovery principle, which cuts your fuel bill 1% for each 45-50°F increase in preheated air temperature.

For application ideas, and facts and figures on the potential savings, write for free 14-page booklet.

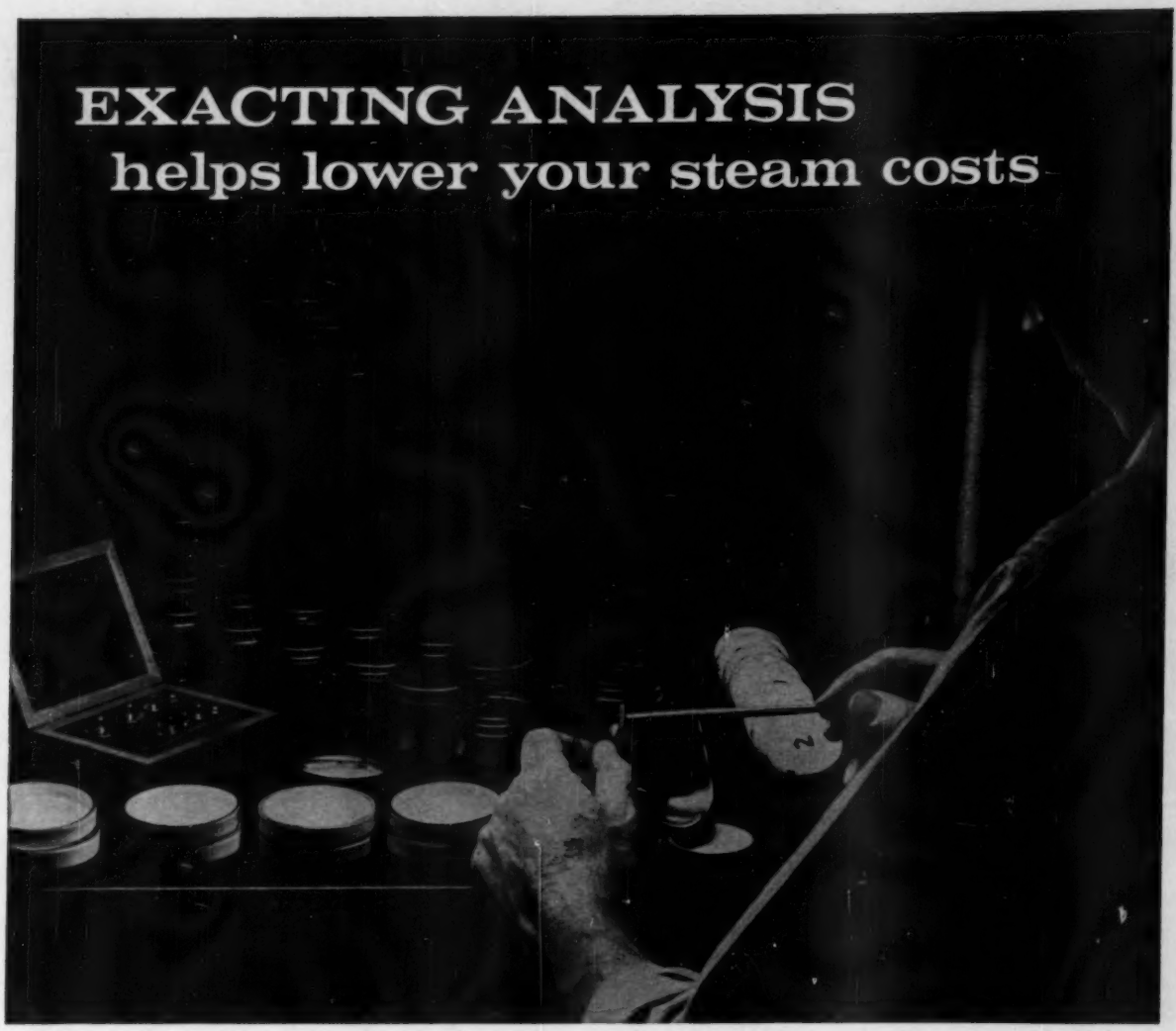
Completely pre-assembled Package Air Preheater is lifted into place at the new plant of Clearwater Finishing, (Division of United Merchants & Manufacturers, Inc.) at Clearwater, South Carolina. Installed at far less cost than a unit requiring on-site erection, this Package Air Preheater will serve a 83,000 lb/hr boiler. It measures approximately 8'x8'x6', and its 4900 sq ft of effective heating surface will recover 290°F from the stack gas.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.
Phone: MUrray Hill 2-8250

For more data circle 516 on Post Card

EXACTING ANALYSIS
helps lower your steam costs



An integral part in the preparation of Valley Camp Quality Coals is an exacting analysis for ash, moisture, and other undesirable materials. This constant quality control helps us to prepare coals with a high degree of uniform heat content, resulting in lowered steam costs for many plants.

Ask our combustion engineering service to show how such analysis can pay off in lowered steam costs for you.

THE VALLEY CAMP COAL COMPANY

Western Reserve Building • Cleveland 13, Ohio

SUBSIDIARIES —

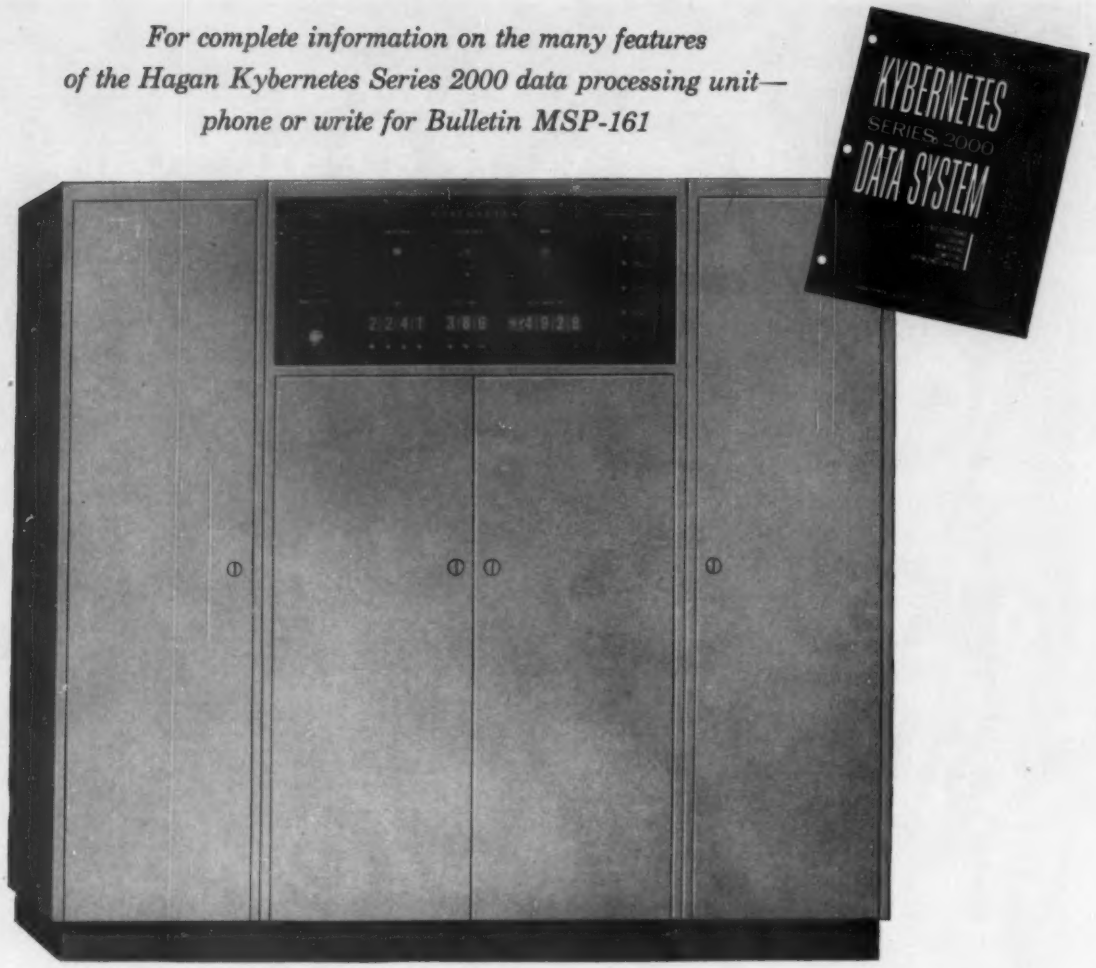
Great Lakes Coal & Dock Co., Milwaukee, Wis. • Great Lakes Coal & Dock Co., St. Paul, Minn. • The Valley Camp Coal Co. of Canada Ltd., Toronto & Fort William, Ont. • Kelley's Creek & Northwestern Railroad Co. • Kelley's Creek Barge Line Inc. • Pennsylvania & West Virginia Supply Corp.

SALES OFFICES —

Philadelphia • Baltimore • Buffalo • Pittsburgh • Wheeling • Cleveland • St. Paul • Cincinnati • New York • Milwaukee • Superior, Wis. • Fort William, Ont. • Toronto, Ont.

For more data circle 517 on Post Card

For complete information on the many features of the Hagan Kybernetes Series 2000 data processing unit— phone or write for Bulletin MSP-161



Hagan Kybernetes® Data Processing Unit Offers...

ACCURACY • LOW MAINTENANCE • MANY EXTRAS

Hagan Kybernetes Series 2000 data processing is an all-electronic system for logging, computing and alarm scanning. Designed around modular chassis, with similar types interchangeable, the system includes linearization, square root extraction, AC to DC conversion, multiplication, division and digital alarm comparison.

Here are some of the unique features of the Series 2000:

CONTINUOUS ALARM SCANNING—Alarm scanning does not stop during logging, trend logging or visual display of any variables.

HIGH SPEED A to D CONVERSION—This feature allows parallel functions such as computing and integration to proceed without interfering with alarm scanning and logging.

HIGH RELIABILITY—Modular construction of plug-in chassis provides reduced down time and no inventory problems.

HIGH ACCURACY—Simplified design and highest quality components provide an overall accuracy of ±0.1% of full scale.

PINBOARD PROGRAMMING—Pre-wired pin board makes selection of operational characteristics, or changing them, extremely simple.

HAGAN

CHEMICALS & CONTROLS, INC.

HAGAN BUILDING, PITTSBURGH 30, PENNSYLVANIA

HAGAN DIVISIONS: CALGON COMPANY – HALL LABORATORIES – BRUNER CORP

For more data circle 518 on Post Card

VOGT identification Disc...

...on top and in sight

makes it easy to identify valves —even in insulated lines

The Vogt tell-all identification disc, on every valve, is permanently located above the handwheel for complete and convenient identification. It shows valve size, catalog and drawing number, materials used for principal parts and primary pressure and temperature ratings. The flat on the handwheel protects the disc in assembly and in service.

Vogt GP Valves are available in a complete range of sizes from ¼" to 2", with HAYNES STELLITE* faced seating surfaces and rated 800 pounds at 850° F. and 2000 pounds at 100° F. (Other types are available through 8" size.)

* Union Carbide Corporation

HENRY VOGT MACHINE CO.
P. O. BOX 1918, LOUISVILLE 1, KY.

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., St. Louis, Charleston, W. Va., Cincinnati, Los Angeles.

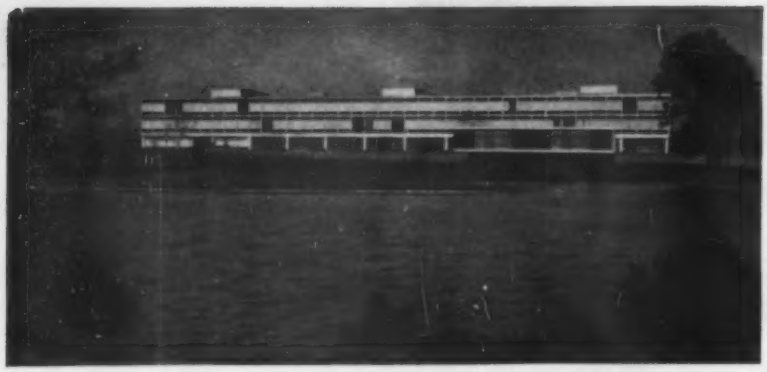
Catalog F-10 is available to you—please send request on your company letterhead. Address Dept. 24A-FPE.

Vogt GENERAL GP PURPOSE Vogt also makes VALVES & FITTINGS

FORGED STEEL

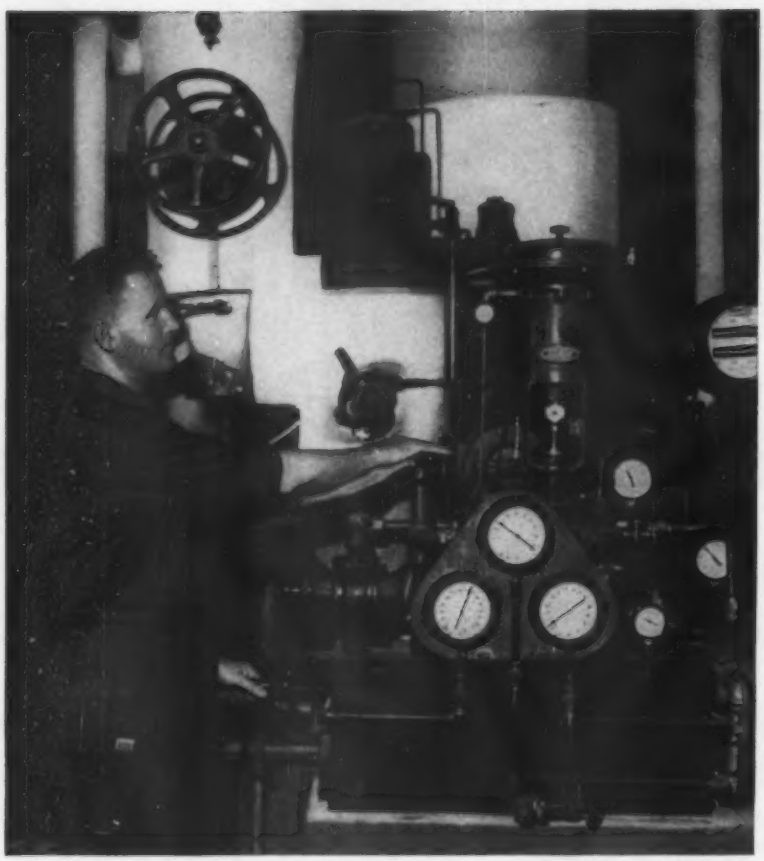
VALVES

For more data circle 519 on Post Card



New home office for Connecticut General Life is a modern structure five miles out in the country.

Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1213

For more data circle 520 on Post Card

HELPFUL BULLETINS

New and revised publications reviewed on these pages offer help on operating and maintenance problems. To order, use the Reader Service Cards, page 105.

GENERATORS, ENGINES

101 Steam Turbine Generators — Design and construction features of large steam turbine generating units are illustrated and described in 40-pp Bulletin 03B9448. Subjects covered range from compact component design to controls and instrumentation, illustrated with photos, drawings and section diagrams, with table of ratings and arrangements. Allis-Chalmers Mfg. Co.

102 Centerline-Mounted Turbine —Bulletin 2001 describes a single-stage, mechanical drive turbine, centerline-mounted to minimize shaft misalignment due to thermal expansion. Dimensional tables are included. Dean-Hill Corp.

103 Gas Engine — Design features and operating advantages of company's V-type turbocharged gas engine designed as a compact, high horsepower driver for centrifugal pipeline compressors, generators and liquid pumps are detailed in 26-pp Bulletin 176. Cutaway view shows component features, and tables list dimensions and specifications. Clark Bros. Co.

104 For Standby Power — Selection and installation of standby electric plants and controls is fully detailed in 8-pp Sweet's File Folder 32C/ON. Practical suggestions are offered on planning and designing the installation, items to evaluate to meet particular requirements are listed, and advantages of gasoline and Diesel-powered generator sets described. D. W. Onan & Sons Inc.

PUMPS, COMPRESSORS

105 Industrial Centrifugal Pumps —Performance characteristics and operation details on company's centrifugal pumps are presented in 14-pp Bulletin 130. Includes selection and specification information, electrical characteristics, outline drawings, photos and diagrams. Eastern Industries Inc.

106 Process Pumps — Heavy duty process pumps designed to meet a variety of severe operating conditions are illustrated and described in 12-pp Bulletin 725.5. Specifications and performance data, parts list, materials of construction and parts interchangeability chart included. Goulds Pumps Inc.

107 Submersible Sewage Pumps — Eight-pp Bulletin 7300 describes company's Demersible sewage pump which can be installed for temporary service or permanently set for continuous service. Features of pump and motor are shown, materials of construction outlined, and performance tables, dimensions and specifications given. The Deming Co.

108 Industrial Air Compressors — Features and applications of company's line of industrial air compressors are detailed in 16-pp Bulletin 94. Characteristics of separate components are covered, and cutaway drawings showing construction features and other details are included. The Cooper-Bessemer Corp.

MECHANICAL POWER TRANSMISSION

109 Controlled Speed Systems — Illustrated with schematic drawings and application photos, this 8-pp bulletin explains company's controlled speed system principle which provides adjustable speeds by converting fixed-speed a-c motors to adjustable speeds on either existing or new equipment. Advantages and typical applications are detailed. U. S. Electrical Motors Inc.

110 Speed Reducers — Advantages of design and operation of Slo-Speed gear motors and motor reducers are detailed in 8-pp Bulletin 198. Illustrates and describes basic types and various modifications, as well as mounting positions possible. Sterling Electric Motors, Inc.

111 Shaft-Mounted Reducers — Modern methods of speed reduction with compact, shaft mounted units in a wide range of sizes and horsepowers are described in 64-pp Bulletin A692. Construction details, dimensions and installation information are given, illustrated with photos and engineering drawings, as well as tables designed to simplify selection of reducers for various applications, power requirements and output speeds. Dodge Mfg. Corp.

112 Industrial V-Belts — This 64-pp industrial V-belt catalog contains pre-engineered data tables for greater convenience. In addition to general information, V-belt drive selection tables, horsepower rating tables and matching data, and other product information are included. Boston Woven Hose & Rubber Co., Div., American Biltrite Rubber Co.

113 Bearing Units — Illustrated and described in 20-pp Bulletin Bu-103-A are bearing units featuring unbreakable malleable housings. Specifications, comparison charts and load rating charts on pillow blocks, flange blocks and take-up units are included. Browning Mfg. Co.

114 Motor Couplings — Geared flexible motor couplings featuring corrosive duty covers are illustrated and described in Folder 2875. Specifications and dimensions, and selection information included. Link-Belt Co.

PACKINGS, SEALS

115 Industrial Packings — Fabric, foil, plastic and filament packings designed for service with strong acids, corrosive fluids, solvents, steam, air, ammonia, gases, hot or cold water, chemicals, oils, gasoline, superheated steam, hot gases and oils are featured in 8-pp Catalog FF-1059. Lists details on composition, application, service information, and temperature limits. Greene, Tweed & Co.

116 Diaphragm Seals — Bulletin 250 describes diaphragm seals for protection of pressure instruments against corrosion and clogging. Contains full description, specifications and prices on various models in the line. Brooks Rotameter Co.

VALVES AND FITTINGS

117 Butterfly Valves — Resilient-seated type butterfly valves for applications where positive tight closure is required are illustrated and described in Bulletin 590X. Advantages and outstanding features detailed. W. S. Rockwell Co.

118 Expansion Joints — Catalog 850 contains 6 pp of data on rubber expansion joints and flexible pipe designed to absorb vibration and noise, prevent stresses due to pipe expansion and contraction, and to compensate for minor misalignment. Table of standard dimensions, and pressure and movement limitations are included. General Rubber Corp.

119 Flange Connections — Featured in this 16-pp bulletin are flange-type hydraulic tube and pipe connection fittings designed for connecting the larger tube and pipe sizes to hydraulic components. Thirty specific models varying in type of line attachment, angle of flow, male or female form, and including several tee combinations, are diagrammed and dimensioned. L & L Mfg. Co.

120 Air Operated Valves — Eight-pp Bulletin HB-7 covers pneumatically actuated Saunders valves featuring close-coupled design for on-off and throttling control. Gives construction details, operating characteristics and specifications. Includes data on valve sizing and flow coefficients to aid in selection. Conoflow Corp.

BOILERS

122 Water-Tube Boilers — Eight-pp Bulletin 4010 describes water tube package boilers designed to fill the steam needs of operations which do not require a boiler with full modulating equipment. Describes control for pressure and temperature operation. Vapor Heating Corp.

123 Automatic Boilers — Twelve-pp Catalog 120 describes a fully-automatic, horizontal Scotch Marine type boilers. Design and construction features are explained and detailed specifications included. Lookout Boiler & Mfg. Co.

WATER, WASTE TREATMENT

124 Boiler Water Carryover — This water conditioning data sheet discusses problems of carryover of boiler water and how to overcome them. Covers mechanical and chemical factors of carryover and the necessity of periodic checks on steam purity. Betz Laboratories, Inc.

125 Zeolite Softeners — Bulletin B5763-A describes problems caused by use of hard water. Design and construction of

company's water softeners is detailed, and selection data, capacities, and other engineering information included. General Filter Co.

126 Upflow Clarification — Features and advantages of the upflow clarification process for sewage and industrial waste treatment are detailed in 8-pp Bulletin B5811. Describes basic functions, and includes pictures, drawings and capacity chart. General Filter Co.

. . . Outstanding Among This Month's Catalogs

127 Flame Spraying Processes — Basic engineering and application data on flame-sprayed coatings of metals, ceramics, carbides and other high melting point materials is presented in 16-pp Bulletin 136B. In addition to covering basic engineering considerations for each process, it includes tables and charts on specific characteristics such as hardness, tensile strength, etc. Metallizing Engineering Co., Inc.

128 Fire Control Tips — This fire control chart, AD3003R8, shows a line of fire extinguishers and detailed information including ratings. Gives data on Class A, B and C fires and extinguishers suitable for each class of fire. Walter Kidde & Co., Inc.

129 A Look At Coal — Importance of coal to the national economy is the subject of this 12-pp booklet. Increased use of coal by the electric utility industry is covered, as well as the use of coal by-products. Peabody Coal Co.

AUTOMATION

130 Computing System — Featured in this 6-pp bulletin is a transistorized electronic computing system designed for both engineering problems and business data processing. Gives specifications, describes applications and components of the system. Royal McBee Corp.

131 Automatic Data Loggers — Featured in this 12-pp bulletin are automatic data loggers for temperature, pressure, flow, humidity and other conditions. Basic units and operation of the loggers are detailed. Hanson-Gorrill-Brian, Inc.

ELECTRICAL

132 Resilient-Mounted Motors — Bulletin MU-245 describes a line of ultra-quiet resilient mounted motors. Features and advantages are detailed, three types of motors described, and details on mounting construction and positions included. Wagner Electric Corp.

133 Pump Motors — Bulletin MU-244 describes doubly-protected, dripproof and totally-enclosed polyphase squirrel-cage motors for close-coupled centrifugal pump applications. Electrical and mechanical features are shown on cutaway view and dimensional data table included. Wagner Electric Corp.

134 FHP Motors — Twelve-pp Bulletin GEA-6424A discusses features and advantages of company's fractional horsepower, Form G, general purpose motors, including capacitor-start, split-phase, permanent-split capacitor, shaded-pole and polyphase motors. Sixteen different kinds of fhp motors ranging from those for machine tools to room air-conditioner motors are shown. General Electric Co.

135 Small Motors, Relays — Typical specifications on a-c and d-c fhp motors, tachometer generators and ultra sensitive relays are presented in Quick Reference File F-9765. Lists rated horsepower, dimensions, special features and typical applications of motors and relays. Barber-Colman Co.

136 Electric Controls — Details on electric controls designed to give stepless torque modulation are presented in 8-pp Form P-75. Describes three types — standard, special and custom — and includes flow chart for easy selection, as well as typical wiring diagram. Warner Electric Brake & Clutch Co.

137 Relay Data — Using photos, line drawings, tables and descriptive material, this 42-pp manual presents detailed data on pile-up relay types, variations in spring arrangement, timing, coil voltage, contact ratings and other useful classifications. Tables give complete relay data. Diaphlex Div., Cook Electric Co.

138 Electrical Equipment Guide — Describing heavy duty electrical transmission and distribution equipment for commercial, industrial and other installations, this catalog digest contains detailed specifications. Presents interrupter switches, medium voltage switchboards, unit substations, power centers, low voltage switchgear, panel type switchgear, bus ducts, bus plugs, motor control centers, panelboards, circuit breakers, safety switches, instrument and control boards. An "easy estimator" is included for convenient price estimating. Available to qualified power engineers, please state job title. Continental Electric Equipment Co.

139 Magnetic Starters — Design and construction features of company's a-c magnetic starters are detailed in 8-pp Bulletin PL 12-8-160. Describes arc quenching principle which provides greater contact life under heavy current loads and severe arcing conditions. The Clark Controller Co.

140 Wire, Cable Terminology — This 52-pp pocket-size glossary of wire and cable terms lists alphabetically the common terms, expressions, and units used in the electrical wire and cable industry. A handy wire data chart is given on the back cover. Standard Wire and Cable Co.

141 Building Wire — Applications of Synthinol, a polyvinyl chloride compound, in wiring are discussed in Bulletin RCP-3001. Physical properties and electrical characteristics of material are detailed, industrial wiring applications described, and specifications included. Rome Cable Corp.

142 Transducer Unit — Features and applications of the Regohm transducer which converts linear or angular motion into electrical action for continuous, automatic control of any electrically controllable device are detailed in Bulletin 5.501. Drawings illustrate details of operation, and specification sheets simplify selection. Electric Regulator Corp.

143 Electrical Insulations — Twelve-pp Bulletin GET-2929A describes in text, tables and illustrations the characteristics and applications of company's insulating materials for electrical equipment. Provides technical data and suggested uses of such products as mica mat, built-up mica, coated materials, varnishes, paints, adhesives, compounds, thinners, irradiated materials, wire enamels and permafils. General Electric Co.

TOOLS

145 Time-Saving Tools — Eight-pp Bulletin E-240 illustrates and describes a line of time-saving tools for a variety of industrial applications, including hydraulic benders, hand benders, ratchet benders, hydraulic pipe pushers, cable puller, chassis punches, knockout punches and drivers, power pumps, bits and chisels. Greenlee Tool Co.

146 Safety Tools — Non-sparking safety hand tools for use wherever inflammable gases, explosives or other hazardous conditions are present are described in 24-pp Bulletin ST-10d. Describes over 400 items for almost every type of hazardous condition. Ampco Metal, Inc.

CONSTRUCTION

147 Watertight Masonry — Major considerations in designing tight masonry walls are covered in 6-pp Bulletin O.M.-8A. Discussed are mortar ingredients and proportioning, compatibility of brick and mortar, control of shrinkage and bleeding, separation cracks, effect of mechanical disturbances, and importance of proper protection. The Master Builders Co.

148 Safety Gratings — Illustrated and described in 24-pp Safety Handbook 60 is a line of safety gratings, stair treads, and safety edgings and step bars. Covers advantages and applications of the six types of safety gratings available for every type of industrial need, and illustrates typical installations in industry. Bustin Steel Products Inc.

149 Floor Gratings, Treads — Three basic grating types used in construction are illustrated and described in this 16-pp bulletin. Includes dimensional drawings of these and other gratings; safe-load tables for steel grating, aluminum grating, sidewalk slabs, others, as well as selection and specification information. Borden Metal Products Co.

150 Aluminum Grating — Rectangular aluminum grating with permanently-locked bars is illustrated and described in this product bulletin. A table of safe loads, as well as tables of dimensional data included. Kerrigan Iron Works Co.

151 For Non-Slip Walking — Illustrated and described in 8-pp Catalog 1935-16 are aggregates and non-slip abrasives used to provide safe and wear-resistant walking surfaces. Recommended uses, specifications and method of application are described. Norton Co.

152 Masonry Fasteners — Fifty-pp pocket-size Catalog 160 lists anchors and fasteners for masonry and hollow walls. Covers machine screw anchors, lag screw expansion shields, machine bolt expansion shields, closed back machine bolt expansion shields, masonry drills, and a variety of anchors. Fully illustrated, includes application information, size data. Diamond Expansion Bolt Co., Inc.

more Helpful Bulletins page 105

If coal piles like this should ever be exhausted, American Industry would grind to a virtual halt — for coal still provides more "Go Power" than all other fuels combined... You can safely rely on Beacon as a dependable source to keep YOUR fuel supply always ahead of need. The 18,000,000 yearly tons we handle include a wide variety of coals with a complete range of properties in any quantity you require. A central control laboratory for combustion studies is supplemented by quality control laboratories at each of our larger mines. Preparation facilities are modern, teletype service connects our sales offices with major mines so that orders can be immediately placed, traced and expedited, and our trained Representatives understand combustion problems, and work their hardest to help you solve them.

BEACON COAL

EASTERN GAS AND FUEL ASSOCIATES

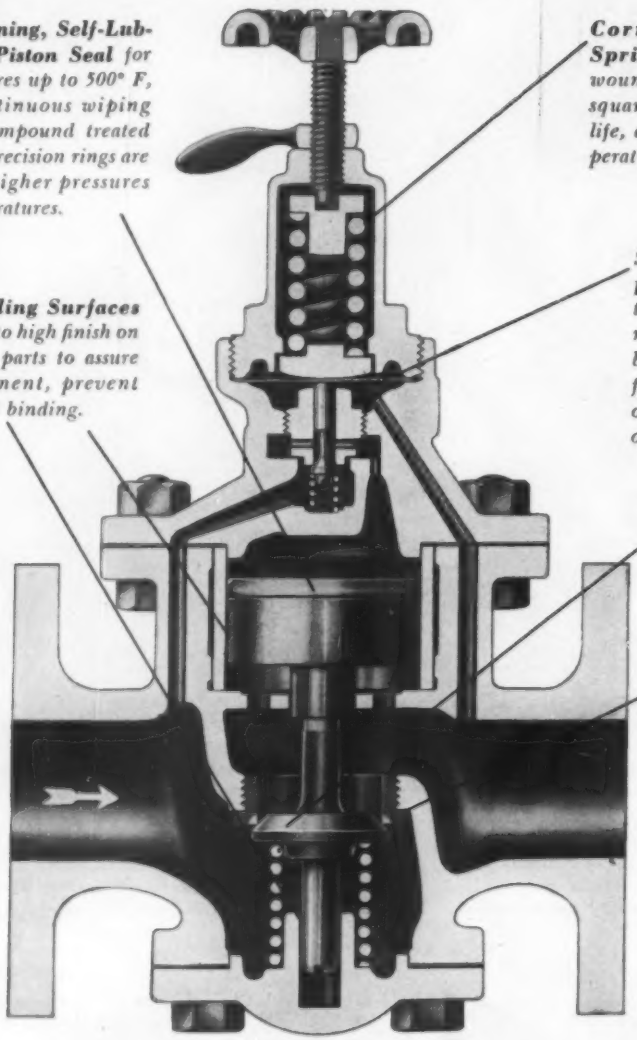
PITTSBURGH • BOSTON • CLEVELAND • DETROIT • NEW YORK
NORFOLK • PHILADELPHIA • SYRACUSE

For New England: New England Coal & Coke Co., For Export: Castner, Curran & Bullitt, Inc.

HERE'S WHY YOU GET EXTRA VALUE IN COMPLETE LINE OF

Self-Cleaning, Self-Lubricating Piston Seal *for temperatures up to 500° F, gives continuous wiping action. Compound treated cast iron precision rings are used for higher pressures and temperatures.*

Long Guiding Surfaces *are ground to high finish on all moving parts to assure true alignment, prevent cocking and binding.*



Corrosion-Resistant Springs *are accurately wound with ends ground square. Maximum spring life, even under high temperature conditions.*

Stainless Steel Diaphragm *responds instantly to any flow change—eliminates stuffing boxes and bellows seals. Diaphragm's full travel is less than its own thickness, can't be over-stressed.*

Single Seated Construction *assures positive dead end shut off.*

Stellited Seating Surface *combined with a hardened stainless main valve provides ultimate in erosion resistance.*

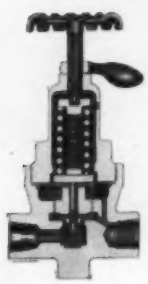
Interchangeable parts *May be replaced without taking valve body off the line, and, even more important, without machining.*

Cutaway of Leslie internal pilot, piston operated reducing valve class LY, shows typical Leslie quality construction features. Throughout the Leslie line, features like these and others presented on the next page are your assurance of lower operating costs and long life performance. They are based on over 50 years of leadership in designing and manufacturing quality regulators.

Internal pilot piston operated reducing valves are available for steam services, up to 2500 lbs., ASA, reduced pressure ranges to 1400 psi. Sizes ½ to 6". Cast iron, bronze, steel or alloy steel construction.

LC-9

IN LESLIE'S REDUCING VALVES AND REGULATORS



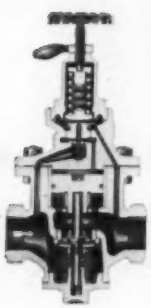
LESLIE SMALL FLOW REDUCING VALVES

Leslie small flow reducing valves are used in pilot plant operations, plastic molding presses, laboratory units, gland sealing, steam sterilization and atomizer units and wherever control of small flows of steam, air, gas or non-corrosive liquids are a problem.

These ½" valves feature simple, direct operated design with screwed or bolted adjusting spring assembly for easy access to the internal parts. No stuffing boxes or fussy seals.

PRESSURE-TEMPERATURE RANGES

BODY MATERIALS AND CONSTRUCTION	CLASS	MAX. INLET PRESSURE PSI		MAX. TEMP. °F.	MIN. PRESS. DROP PSI	REDUCED PRESS. RANGE PSI
		STEAM	COLD LIQUID AIR OR GAS			
BRONZE Screwed Bonnet	LCA	—	400	150	10	5-285
	LCB LCC LCD	300	400	550	10	10-285
	LCLA	—	400	150	10	2-35
	LCLB LCLC LCLD	300	400	550	10	2-35
STEEL Thru-bolted Bonnet	LCL(B)S LCL(C)S LCL(D)S	600	1000	750	10	25-600 10-50



LESLIE REDUCING VALVES FOR AIR OR GAS SERVICE

Leslie internal pilot, piston operated reducing valves offer a combination of accurate regulation and low maintenance service, and are used for accurate control of air or gas with inlet pressures up to 400 psi at 150° F.

Accuracy of regulation is comparable to instrument control with full flow for equivalent pipe size. Valves feature 99% accuracy of regulation at rated capacity.

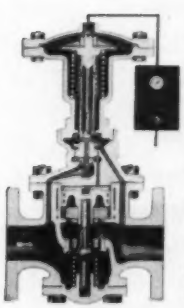
Positive, bubble tight shut-off is provided by resilient, single seated valve disc. Fully guided main valve, stainless steel diaphragm and non-corroding internal springs assure long, trouble-free operation.

PRESSURE RANGES AND CONSTRUCTION

CLASS	SIZE (Inches)	MAXIMUM INLET PRESSURE & TEMP.	REDUCED PRESSURE RANGE-PSI		BODY MAT'L.	END CONNECTIONS
			MIN.	MAX.		
LA-S LAE-S	½-4	25-400 psi 150° F max.	5*	285	Bronze	½-2" 300 lb. screwed ½-4", 150 & 300 lb. MSS flanged
LAK LAEK		25-400 psi 150° F			Cast Iron	½-2" 250 lb. screwed 1½-3" 250 lb. ASA flanged
		25-175 psi 150° F max.				1½-4" 125 lb. ASA flanged

*5% of inlet pressure over 100 psi

REMOTELY ADJUSTED REDUCING VALVES



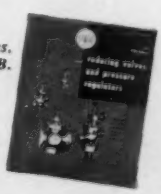
Operating characteristics of Leslie remotely adjusted reducing valves are identical to manually adjusted types. The remotely adjusted reducing valve is adjusted to the desired pressure setting by air pressure from an air loading device. The constant loading force on the upper diaphragm opens the pilot valve and is balanced by a constant reduced pressure proportional to the loading force.

The air loading panel eliminates hazardous or inconvenient adjustments and provides fast means of readjusting pressure to meet changing requirements.

REMOTELY ADJUSTED REGULATING VALVES

TYPE	SIZES AVAILABLE (Inches)	BODY MATERIALS AVAILABLE	INLET PRESSURE RANGES (PSI)	MAXIMUM REDUCED PRESS. (PSI)
Small flow, internal pilot actuated, diaphragm operated	¼, ⅜, ½	Bronze	20-300 psi 550° F steam 20-400 psi 150° F air	175
Internal pilot actuated, piston operated	½ - 6	Cast Iron Bronze Cast Steel	25 psi up to 600 psi, 750° F	175
Internal pilot actuated, piston operated for high pressure service	½ - 3	Cast Steel and Alloy Steels	300 psi up to 3000 psi	700

For sizing and capacity data on this Leslie line of valves, contact your Leslie engineer or write for Bulletin 5302B.



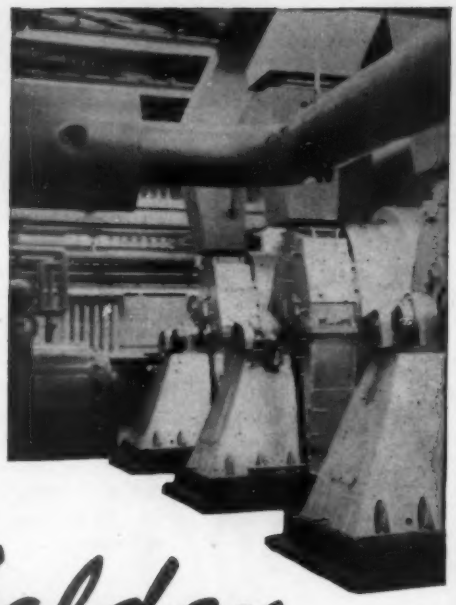
TRADE LESLIE MARK

REGULATORS and CONTROLLERS

Leslie Co.; 702A Leslie Building, Lyndhurst, New Jersey

Over 275 Factory-Trained Engineers At Your Service—Nationwide!

For more data circle 522 on Post Card



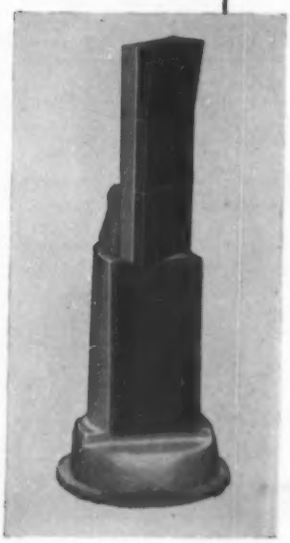
With RILEY PULVERIZERS Installed In Your Plant

Silence is Golden

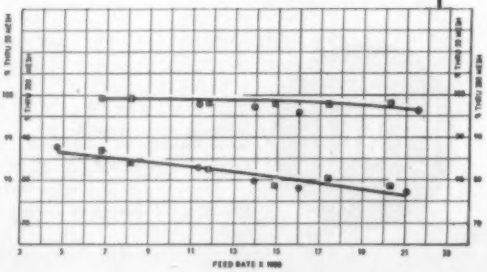
... Because Riley Pulverizers Operate Quietly

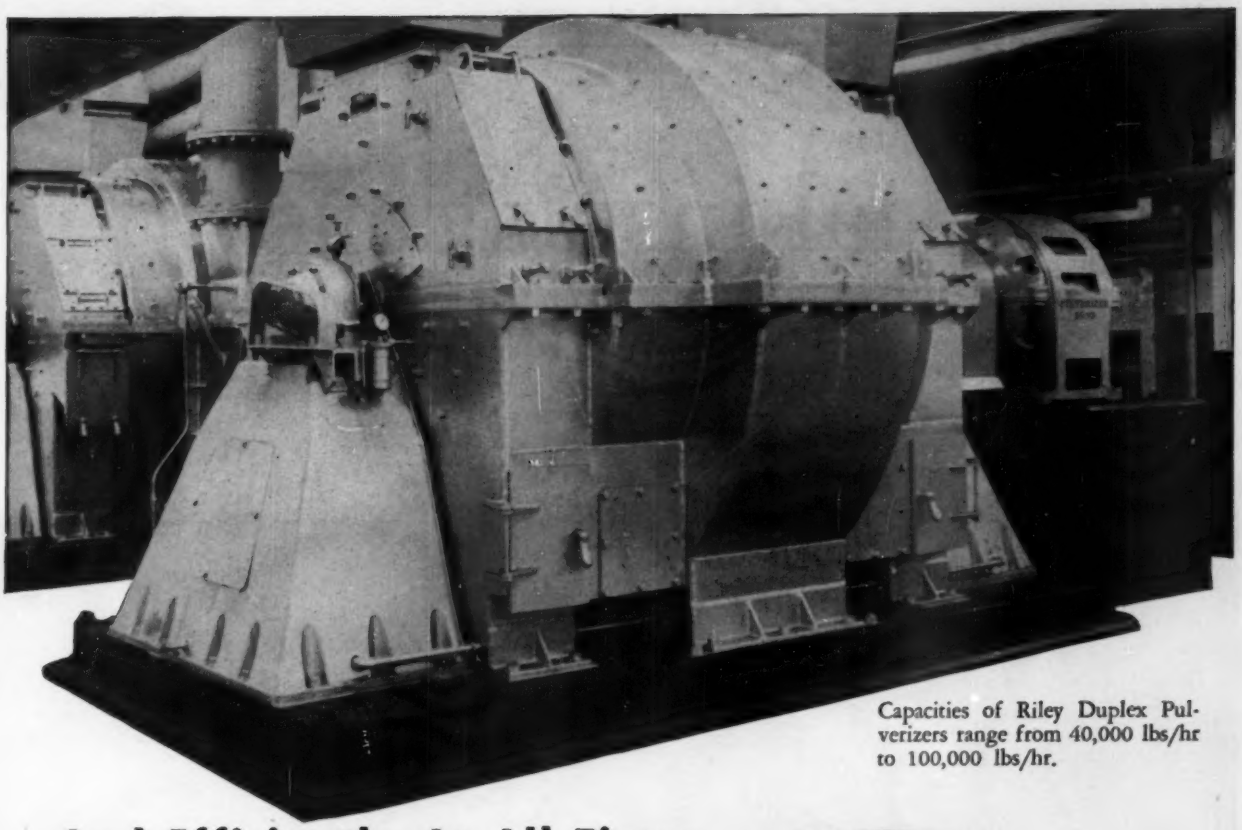
Other Advantages of Riley Pulverizers

- Wide fuel type range
- No loss of capacity with wet coal
- Ease of maintenance — minimum lubrication
- No adjustment needed to sustain fineness
- High primary air temperatures are used
- Sustained high fineness with tungsten carbide faced pulverizing elements
- Ease of automatic regulation
- Low power consumption
- Explosion proof
- Compact design, low foundation cost
- Rejections easy to remove
- Pressurized operation
- Wide capacity selection from 3,000 lbs/hr to 100,000 lbs/hr



At left is a typical pulverizing element faced with high grade erosion resistant tungsten carbide. At right are the results of fineness test conducted on a duplex type pulverizer. Test #1 ○ before elements were replaced; test #2 □ after new elements were installed. Results show no appreciable drop in fineness and capacity in either case.

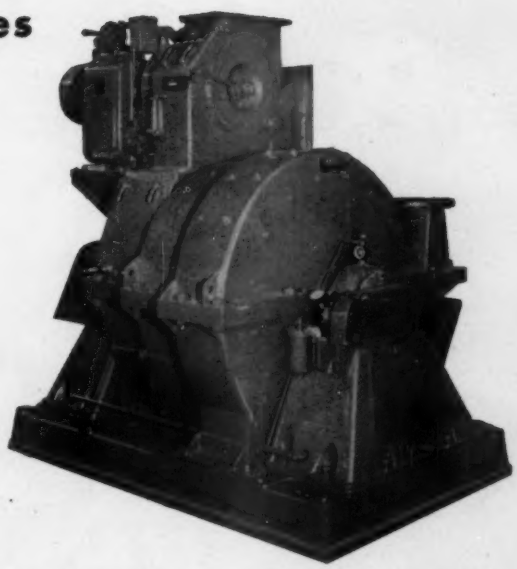




Capacities of Riley Duplex Pulverizers range from 40,000 lbs/hr to 100,000 lbs/hr.

And Efficiently At All Times

The Riley Pulverizer reduces coal to high fineness by attrition with no metal-to-metal contact . . . coal particles are reduced in size by impact against rotating and stationary pulverizing elements . . . *the action is soundless* . . . perfect balancing of all rotating elements assures smooth vibration-free operation. Visit one of the hundreds of plants using Riley Pulverizers . . . you'll be amazed at how comfortably you can hold a normal conversation in the pulverizer room.



Single Riley Pulverizer capacities range from 3,000 lbs/hr to 30,000 lbs/hr. Unit is equipped with Riley metering coal feeder with magnetic separator.

You'll find all the many operating and design characteristics of Riley Pulverizers fully explained in a new Pulverizer Catalog. For your own copy ask a Riley Representative in one of these cities . . . Boston, Charlotte, Chicago, Cincinnati, Cleveland, Detroit, Houston, Jacksonville, Kansas City, Los Angeles, New Orleans, New York, Philadelphia, Pittsburgh, Portland, St. Louis, St. Paul, Salt Lake City, San Francisco, Seattle, Syracuse.

RILEY

STEAM GENERATING & FUEL BURNING EQUIPMENT

RILEY STOKER CORPORATION, WORCESTER, MASS.

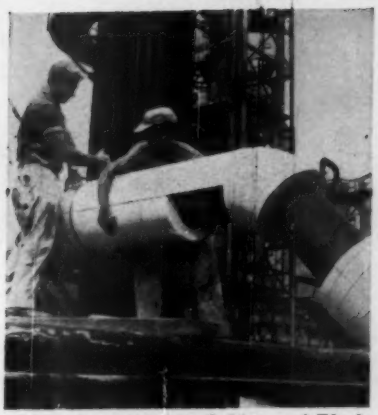
For more data circle 523 on Post Card

ANOTHER FIRST FROM JOHNS-MANVILLE

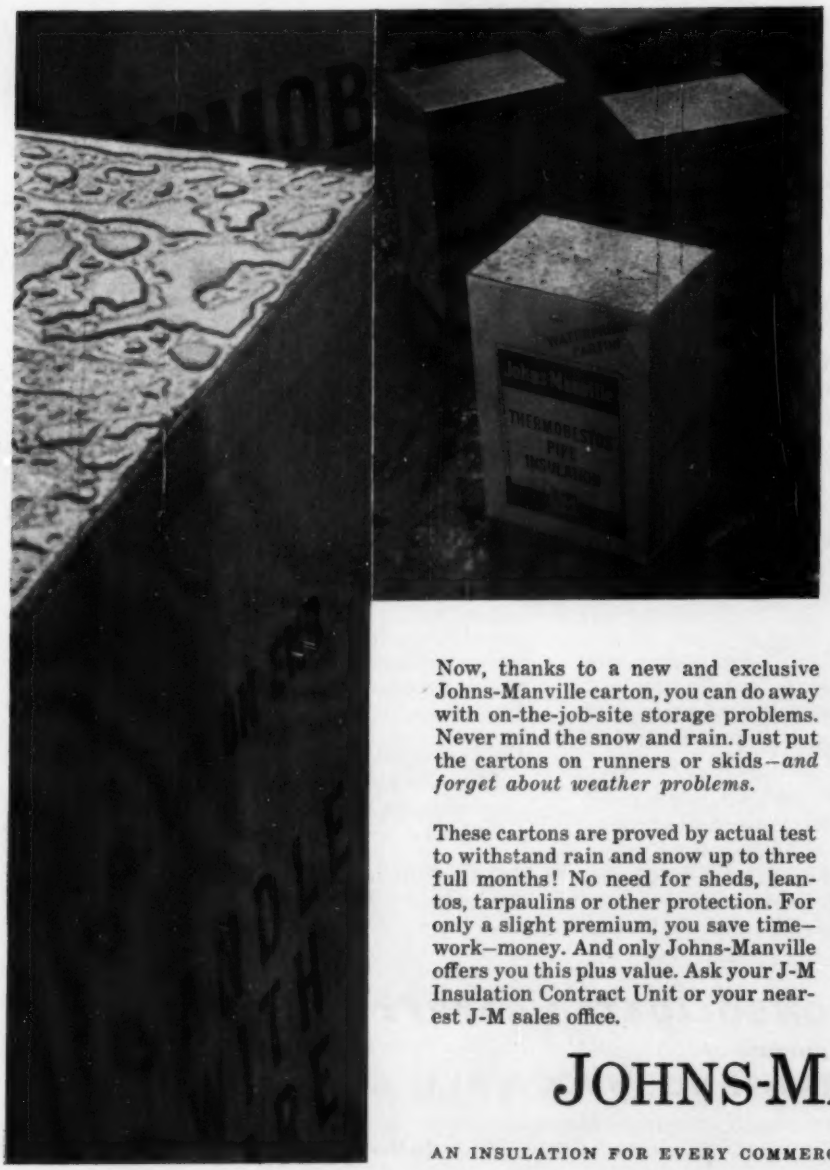
Industrial insulations in weatherproof cartons!

All these dollar-saving advantages for pennies more!

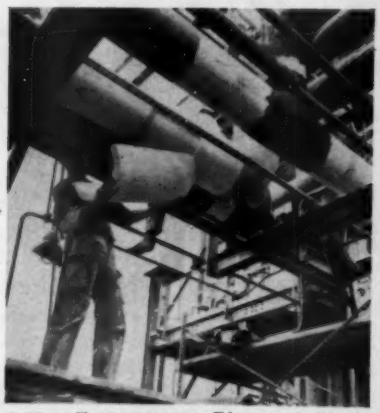
- **NO SHEDS TO BUILD**
- **NO HEAVY TARPAULINS TO HANDLE**
- **WEATHERPROOF FOR A MINIMUM OF 3 MONTHS**
- **SAVE TIME, WORK, MONEY ON THE JOB**



J-M THERMOBESTOS® Pipe and Block Insulation for temperatures to 1200 F., light in weight, top mechanical strength, low *k* factor.



J-M SUPEREX® Block Insulation is furnished in flat or curved blocks, and is recommended for equipment operating at temperatures up to 1900 F.



J-M 85% MAGNESIA Pipe and Block Insulation is designed for use up to 600 F. on heated piping and equipment. The standard for decades.

Now, thanks to a new and exclusive Johns-Manville carton, you can do away with on-the-job-site storage problems. Never mind the snow and rain. Just put the cartons on runners or skids—*and forget about weather problems.*

These cartons are proved by actual test to withstand rain and snow up to three full months! No need for sheds, lean-tos, tarpaulins or other protection. For only a slight premium, you save time—work—money. And only Johns-Manville offers you this plus value. Ask your J-M Insulation Contract Unit or your nearest J-M sales office.

JOHNS-MANVILLE

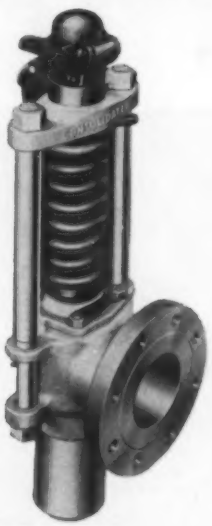
JOHNS-MANVILLE JM PRODUCTS

AN INSULATION FOR EVERY COMMERCIAL AND INDUSTRIAL USE

For more data circle 524 on Post Card

greater capacity

CONSOLIDATED "MAXIFLOW" SAFETY VALVES set a new standard of capacity and tightness in high pressure steam service



Consolidated "Maxiflow" Safety Valve, Type 1700 Series. Sizes: 1½" through 6". Pressure to 3000 psi. Temperatures to 1120° F. for superheater and reheater service.

Consolidated "Maxiflow" Safety Valves have greater discharge capacity, seat tightness, and shorter blowdown essential to optimum service on today's high-pressure, high-temperature steam generating equipment.

The highest degree of valve tightness is achieved with the Thermodisc Seat, an exclusive Consolidated feature. This unique seating design permits rapid equalization of temperature differentials set up when a high pressure valve reseats after blowing. The Thermodisc minimizes thermal stresses which cause seat distortion. Result: permanent tightness that saves on steam and valve maintenance.

The Consolidated "Maxiflow" is designed to function with a minimum blowdown. Blowdown adjustment can be made with the valve under full pressure.

Bulletin 707B contains complete details about Consolidated "Maxiflow" Safety Valves. Write for a copy.

MANNING MAXWELL & MOORE INC. TRADE MARK

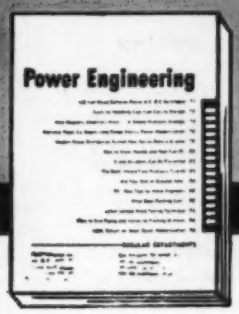
CONSOLIDATED SAFETY VALVES

A product of

MANNING, MAXWELL & MOORE, INC.

Valve Division • Stratford, Connecticut
In Canada: Manning, Maxwell & Moore of Canada, Ltd., Galt, Ontario

For more data circle 525 on Post Card



ATOMICS

308 EAST JAMES STREET
BARRINGTON, ILLINOIS

A POWER ENGINEERING FEATURE FOR UTILITY & MAJOR INDUSTRIAL EXECUTIVES

A. W. Kramer, Editor

A Periodic Report on Atomic Energy Development Throughout the World
Published by Technical Publishing Co.

May 1960

Report on VBWR. The Vallecitos Boiling Water Reactor started power operations on October 20, 1957. In the following two years of operation, it proved to be an extremely effective and flexible facility and, in addition, produced 25 million kwh of electrical energy.

The direct-cycle boiling water reactor is the simplest of all reactor systems, since the steam produced in the reactor core is used directly in the steam turbine-generator with no intermediate heat exchangers. The steam is therefore slightly radioactive. This fact has been the cause of some apprehension in the minds of those not familiar with this type of reactor system. They have been concerned about the radioactive deposits that might accumulate in the steam system, particularly as the result of operation with ruptured fuel elements.

The actual operating experience both at Argonne's Experimental Boiling Water Reactor (EBWR) and General Electric's Vallecitos Boiling Water Reactor (VBWR) has proved that this apprehension is unjustified, that the radioactive contamination is far less than originally expected, and that even continued operation with damaged fuel elements resulted in no significant operating or maintenance difficulty.

With the experimental program for which VBWR was originally constructed completed, extensive modifications are now being made to carry out further development programs. These modifications necessitated the almost complete disassembly of the reactor as well as extensive modification of the piping; consequently, the operation provided a welcome opportunity to investigate further the various effects of two years' operation. The advanced test programs center about the study of the parameters associated with coolant flow and the investigation of the characteristics of high-power density, high-specific-power boiling water reactor cores. The required modifications consist of the installation of an entire new core structure, and the replacement of the existing forced-circulation pump with two new higher head pumps. The options of using either forced or natural circulation and either single or dual cycle will be retained.

Since the field experience in the VBWR modification is of interest to others concerned with boiling reactor operation, we are pleased to be able to present the following exclusive account of the work by two General Electric engineers:

Field Experience in VBWR Modification. By L. Kornblith and R. H. Leyse, Atomic Power Equipment Dept, General Electric Co

Before the modification of the Vallecitos Boiling Water Reactor was undertaken a very substantial effort was devoted to planning the general sequence of the operations for the disassembly of the reactor, the necessary modifications, and to writing detailed procedures for each operation. This program began several months before the planned shutdown date in order that adequate consideration could

be given to the problems involved, and so that all people concerned could review the procedures.

As a consequence of this planning we were able to achieve our two principal goals during modification — minimum radiation exposure of personnel and maximum possible reduction of shutdown time.

One of the preliminary studies covered possible methods for decontaminating the reactor vessel and the large stainless steel piping. The decontamination was considered to be desirable, since the large piping (up to 18-in.) was to be cut in several places to install a second pumping loop. A number of test coupons, which had been in various sections of the system for many months, were used for evaluating various procedures. After checking the piping to be cut, however, the existing contamination levels were found to be tolerable, and it was decided that the time and cost involved in over-all system decontamination would not be justified. The decision was based on the relative personnel exposure from cutting and from decontamination, in the problem of disposing of the large amounts of liquid waste resulting from system decontamination, and, on the cost and time involved. All of the pipe-cutting was done with the use of fresh-air masks to prevent inhalation hazards. The use of local ventilating hoods for the cutting allowed work in other parts of the building to proceed normally. Typical radiation exposures for people doing this work were 30-40 mr per day, which is below AEC tolerance limits.

During most of the time VBWR was in operation it maintained thermal power levels between 20 and 30 Mw and at a pressure of 1000 psi. The fuel was removed from the reactor late in December 1959, with the same equipment and techniques used during normal loading. The reactor head was then taken off, and six days later the control rods and all the internal structure had been removed from the vessel. No chemical decontamination was done although some parts were spray-painted after removal in order to bond loose contamination.

The control blades were the first items removed after the vessel was opened. It had been anticipated that it would be necessary to use shielding to reduce the radiation exposure to personnel, and a temporary cask had been prepared for this. However, preliminary measurements indicated that this would not be required. After attaching the necessary rigging to a control blade, the enclosure was evacuated except for three men who worked from the crane bridge. The blade was then hoisted into the air, moved over the fuel storage pool, and lowered into the water. The maximum radiation reading during this operation was 1 r/hr on the crane bridge, approximately 35 ft away from the exposed control rod. Total exposure to the crane operators was only 23 mr during the removal of the seven control blades.

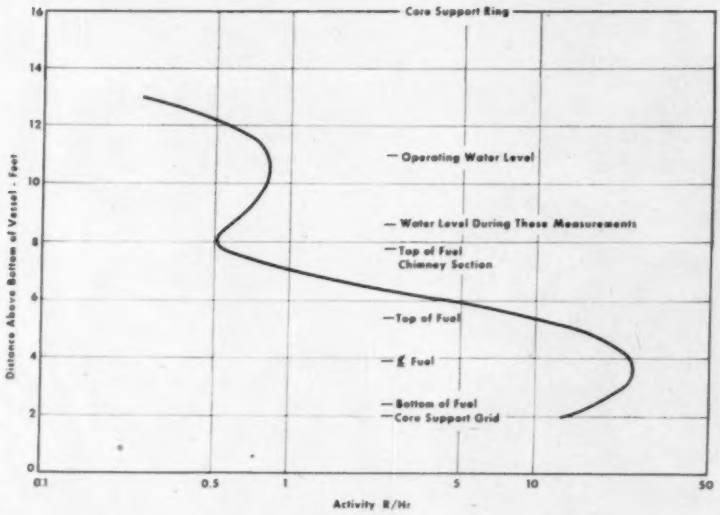
The method of removing the remaining components was governed by radiation levels. Fortunately, with boiling water reactors there is a large decontamination factor in passing from the water to the steam phase during reactor operation. For this reason, materials which had been operated in the upper steam-phase region of the reactor vessel had very low activity levels—25 mr/hr and less. The steam baffle had a maximum activity of 15 mr/hr at a distance of 4 inches and was removed by direct handling. Structures beneath the operating water level of the reactor vessel had greater activity levels. The lower grid, which was within five inches of the fuel, had a maximum activity of 7000 r/hr, measured within the grid. This grid was handled in the same way as the control rods. The grid remained unshielded for less than two minutes during the transfer to the water storage, and the total exposure of the crane operators at a distance of 40 ft was 125 mr. The maximum reading during the transfer was 4.5 r/hr.

The activity levels of the reactor vessel and internal structures were measured in detail after disassembly operations were completed. The core support grid was the most highly radioactive component. Maximum radioactivity was at the center of the grid as shown in the tabulation on the next page:

Location on Grid	Activity r/hr (within grid structure)
Center	7000
Edge of core	2000
Corner (15 in. out from edge of core	60

These measurements were made while the grid was under water in the spent fuel pool. The ionization chamber was sealed from the pool by an aluminum thimble inserted into various cells of the grid.

Vertical traverses of activity level were taken of the vessel wall in each quadrant. A typical traverse is shown in the accompanying graph. Maximum activity was at the elevation of the core centerline. The slight peaking of



Curve showing the distribution of radioactivity within the reactor vessel.

activity at the operating water level is possibly caused by increased deposition of surface contamination. The ionization chamber was again protected from the water by an aluminum thimble which was held within one-half inch of the wall of the reactor vessel. Some increase of indicated activity is to be expected at the 8½ ft level, because above this point there was no water shielding between the thimble and the wall of the vessel. However, the steady increase in activity as the chamber was moved further above the water can be explained only as an increasing activity of the vessel wall, peaking at the operating water level.

The activity at the corners of the upper core grid was about 2 r/hr at two inches. This grid was located directly above the fuel chimney section. Activity levels of the core support rods were measured, but because of poor geometry of the ionization chambers relative to these narrow selections, the measurements may not be directly compared to those of the reactor vessel. The gamma activity of the core support ring was only about 5 mr/hr at contact.

Most of the components had a thin reddish-brown deposit on them which was probably magnetite. Radiochemical analysis of this deposit showed that the major part of the activity was cobalt-58 and cobalt-60, with lesser amounts of zinc-65, iron-59, manganese-54, and zirconium-95. The presence of these isotopes is explained by the materials of construction of the reactor system, with the exception of the Zr^{95}, which is a fission product.

The reactor plant has been experimentally operated with fuel elements fabricated with intentional defects. Operations with these fuel elements over a

period of 1½ years have resulted in the loss of about 200 grams of uranium dioxide to the reactor vessel. It is significant that Zr^{95} levels are very low relative to Co^{60}, and that Zr^{95} is the only fission product observed in the deposited material. The bottom of the reactor vessel has been wiped and sampled with no evidence of any large amount of UO_2. Apparently, the UO_2 was removed from the reactor complex by the ion exchange and filtration system, which are parts of all BWR systems.

The reactor pressure vessel is fully lined with type 304L stainless steel. In the heads and cylindrical section, the lining is a bonded clad, but on the inside of the two flanges, a formed stainless steel liner was applied by seam- and plug-welding. This liner was found to be cracked. The radiation field at the region of defective liner was 25 mr/hr, with shielding provided by a high water level in the vessel. With an activity level this low, it was possible for maintenance personnel to work within the vessel without undue difficulty.

Cracking of the liner occurred at plug welds and seam welds only. There was no cracking of material remote from weld areas. The liner was cut free of the seam welds and was then pulled from the wall of the vessel. With the liner removed, it appeared that most of the plug welds had never been adequately bonded to the carbon steel flange. Although these welds appeared satisfactory from the outside of the liner, there seemed insufficient weld penetration into the flange.

Early failure of these plug welds led to excessive stressing of the seam welds and the few remaining plug welds. These stresses resulted from the differences in expansion and contraction of the stainless clad and carbon steel flange as the vessel was heated and cooled. The coefficient of expansion of stainless steel is about 1½ times that of carbon steel. The vessel had been heated to 550 F and cooled to room temperature approximately 200 times before the cracking was found. The combination of stress concentration and temperature cycling was a sufficient condition to cause the cracking.

After removal of the liner, all of the welds were ground down and dye-penetrant-tested to determine whether or not there were any cracks penetrating into the base metal. None have been found in the vessel flange. The head flange has not yet been inspected, but the visible evidence indicates the conditions there to be the same as on the lower flange. The vessel was inspected and found to continue to comply with the boiler code standards. New liners will be installed, probably using Inconel for the lower flange and carbon steel for the upper. The liners will be welded at the top and bottom edges but not plug-welded. Expansion problems are not anticipated with these materials. Fortunately, this problem occurred at a time in our program when the major part of the work was taking place outside of the reactor vessel. Consequently, it has been possible to make the repairs in parallel with the planned work, and no delay has resulted.

The conversion of the VBWR is proceeding with minimum delay and minimum radiation exposure. No cases of personnel contamination have occurred. Removal of structural components from the reactor vessel has not been difficult. There are no large transported activity deposits anywhere in the reactor vessel, and there has been no need for costly decontamination procedures. Radioactivity problems have been minimized by the high water-to-steam phase decontamination factor that is characteristic of boiling water reactors, and also by the steady cleanup of process water with ion exchangers during plant operation. The entire procedure has been expedited by careful advance planning. The demonstration that the conversion of a reactor such as this is practical is of major significance to designers of reactor experiments.

Andrew W. Kramer

Performance makes the world of difference

POWELL NUCLEAR VALVES

for Atomic Power Plants

4-inch, 300-pound Steel Bell-O-Seal "Y" Valve for molten metal service. It has hard faced seat and disc, and is electric motor operated.

Powell . . . world's largest family of valves

Powell has precision-designed special Valves to handle molten metals and other radioactive materials in atomic power plants—vital and hazardous fluids that must pass through the valves without the slightest leakage or failure.

Painstaking quality control is rigidly enforced in every step of manufacture. Every machine operation is accurately gauged. All parts are thoroughly cleaned and degreased. And every nuclear valve is given an actual line test—plus a snifter or mass spectrometer test.

For complete information, consult your Powell Valve distributor. Or call us direct. We'll be pleased to inform you about Powell Nuclear Valves as well as our complete line of Powell Quality Valves.

THE WM. POWELL COMPANY • DEPENDABLE VALVES SINCE 1846 • CINCINNATI 22, OHIO

For more data circle 526 on Post Card

PEABODY's Two Billion Tons Of Coal Reserves Assure You Of An Abundant Fuel Supply... Far Into The Future!

Peabody Coal Company's *two billion tons of proven reserves* are your assurance of a dependable source of fuel for the long pull. These reserves... along with Peabody's continuous development of productive mining properties—economically accessible to the nation's inland waterways and rail facilities... are your guarantee of an abundance of power for years to come.

Whether you use a carload or a trainload, your business is important to Peabody. From consultation on power problems to the end result Peabody offers a complete coal service. Contact your nearest Peabody office for complete details.

Learn more facts about Peabody Coal... its importance to the nation's economy and your business. Send for Peabody's new FREE booklet, "COAL... ANCIENT STOREHOUSE OF MODERN LIVING." Write Department PE.

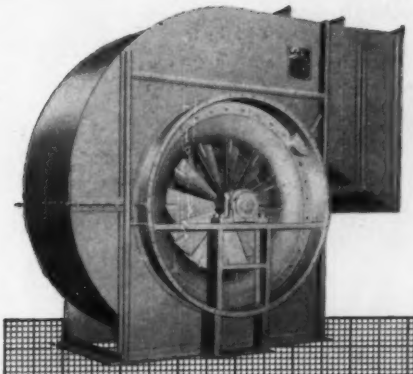
power for progress

PEABODY COAL COMPANY

Peabody Plaza • 301 Olive Street • St. Louis 2, Missouri

Offices in: Chicago, Columbus, Des Moines, Detroit, Indianapolis, Kansas City, Louisville, Madison, Wis., Memphis, Minneapolis

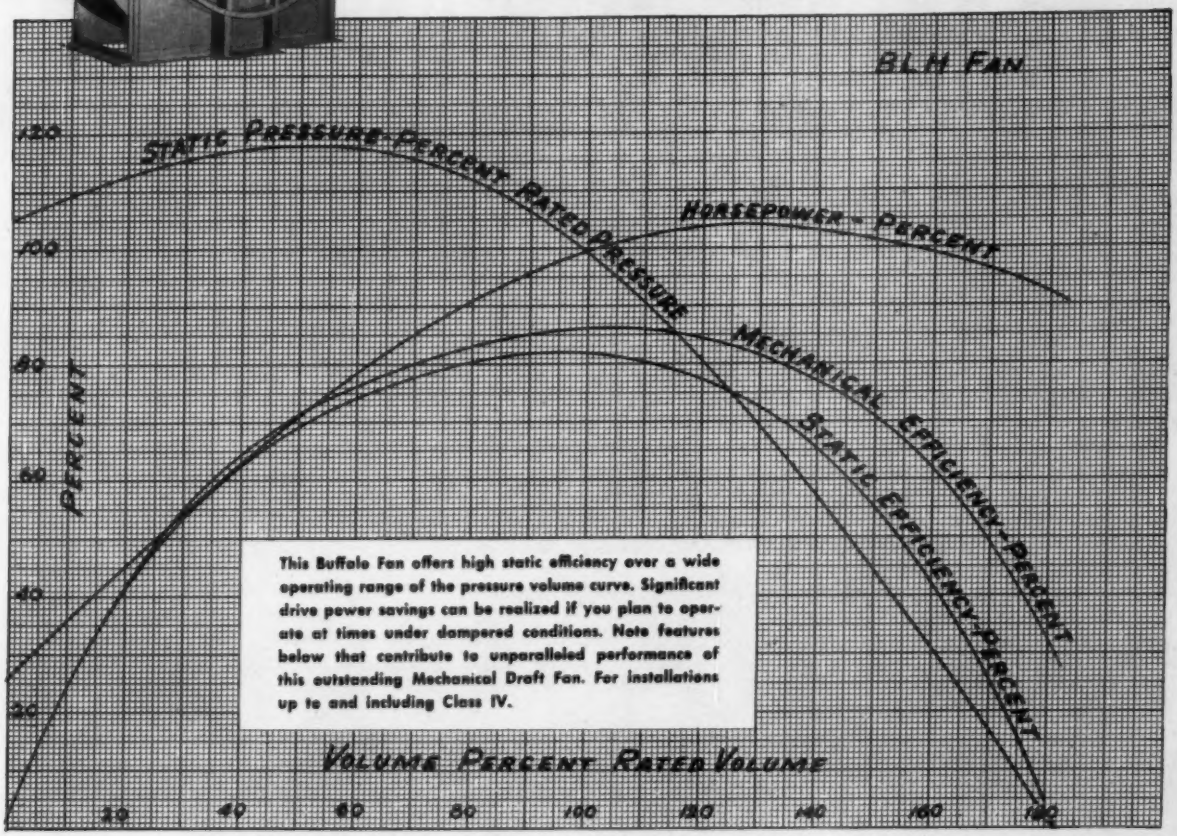
For more data circle 527 on Post Card



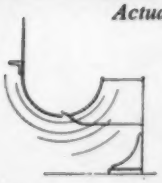
MAXIMUM EFFICIENCY

OVER BROAD OPERATING RANGE

THAT'S THE BUFFALO "BLH"



Actual performance curve of Type "BLH" Fan. Write for Bulletin FD905.



EFFICIENCY AT INLET. Cross-section of inlet shows smooth passage into wheel formed by curved inlet bell and mating wheel flange. No flat spots to cause turbulence. Fixed or variable inlet vanes available (without reducing efficiency).

EFFICIENCY IN THE WHEEL. Showing deep, **backward curve** of blades in "BLH" wheel for smooth, quiet handling of air spun into the wheel in the direction of rotation. No waste turbulence.

EFFICIENCY THRU THE HOUSING. Not only is the "BLH" housing streamlined throughout, but its unique divergent outlet delivers air to duct with easy, gradual enlargement for best distribution and static conversion.

"Buffalo"

BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

Buffalo Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Special machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more data circle 528 on Post Card

You get these benefits when you install YARWAY GUN-PAKT EXPANSION JOINTS

Why do industrial plants, institutions, universities and central heating plants SPECIFY and INSTALL Yarway Gun-Pakt Expansion Joints?

Because with Yarway you get:

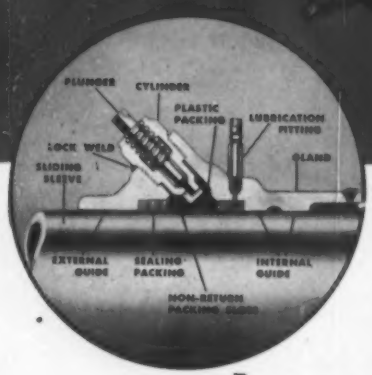
- **CONTINUOUS SERVICE**
  Costly shutdowns are eliminated. Packing is seldom necessary but may be added *under full line pressure.* No vents are necessary. Never needs repacking.
- **RUGGED DEPENDABILITY ALL STEEL CONSTRUCTION**
  Durable chromium plated seamless steel sleeves. No chance *of metal fatigue.* Wrought steel bases provide rugged, positive anchorage.
- **INTERNAL AND EXTERNAL GUIDES**
  Positive alignment of sleeve in stuffing box *—where it counts!*
- **LIGHT WEIGHT, STREAMLINED DESIGN**
  Requires less space to install—less space to maintain—smaller manholes.

Many Gun-Pakt joints have been *in service over 25 years with only nominal maintenance*—no major repairs or periodic overhauls. Maintenance costs are negligible—records show average to be one manhour and 65 cents worth of packing per joint per year. AND—NEVER A SHUTDOWN FOR REPACKING!

YARWAY field engineers are qualified to advise on installation and service—at no cost to you. Investigate today. Write for Bulletin EJ 1917 ('59).

FOR YOUR NEXT PIPELINE JOB—BE SAFE—BE SURE! SPECIFY YARWAY GUN-PAKT.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



Cross-section of Gun-Pakt feature. To add packing, just insert a plug and turn the plunger. Note non-return packing slots.

YARWAY GUN-PAKT

For more data circle 329 on Post Card

TRACERS

Power Engineering's Monthly Probe of Power Facts

Bristol Siddeley Engines of Bristol, England, has been using an aircraft engine to generate electricity for additional power at reasonably low cost. Gas turbine engine hooked up to an electric generator makes a factory power unit of low capital cost, the ability to start quickly, low maintenance and labor costs, small size and reliability. Even though fuel costs are higher than a conventional oil-fired steam generating station, other advantages more than make up for the difference, Siddeley reports.

One of the sights at the American Power Conference held in Chicago at the end of March was an automobile powered by sunshine. International Rectifier Corp has taken a 1912 Baker electric and mounted a panel of 10,000 silicon solar cells on its roof. Sunlight energizes electrons in the cells which charge the car's 72-v battery system. For a full account of the advances and developments reflected at the APC, see page 78.

Standard Oil has a new fuel available that has been tailor-made for diesel engines. Known as Premier diesel fuel, its development has aimed at cutting down on wear of injectors, better burning, reduction of repairs, and minimum engine deposits, smoke and odor.

The no-maintenance hyperbolic cooling tower with a working life of over 30 years (at a competitive cost) is already within sight. B. F. Rish of Britain's Central Electricity Generating Board (London) points out this in his article on hyperbolic cooling towers, page 74 of this issue. Included are some significant comparative costs, both for initial investment and for maintenance of the two types of towers — hyperbolic and mechanical-draft.

Okan Pipeline Co of Tulsa is using a Solar Aircraft Co Saturn T-1000 gas turbine engine with a booster pump, to increase the capacity of its 407-mile-long pipeline from southwestern Kansas to Tulsa. Engine will burn liquid butane most of the time but will be capable of burning other refined liquid fuels such as kerosene or gasoline. Fuel will be taken from the main pipeline and stored at the pump station site.

Round-up review of the present stage of developments in new methods of power generation was presented by Westinghouse recently. Spotlight was on magneto-hydrodynamic generators (MHD), high-temperature fuel cells, thermoelectricity, and thermionic generators. Said J. A. Hutcheson, engineering vice-president: "No single *one* of these new methods of energy conversion is likely to be the 'one way to do it'; we will find no *one* answer to our varied growing needs for electric power."

Single-stage flash evaporators incorporated into steam power plant cycles effect an improvement in heat-rate over cycles using submerged-tube evaporators. So report E. F. Stalcup and R. L. Coit of Westinghouse in their article on flash evaporators for supplying boiler feedwater, page 60 of this issue.

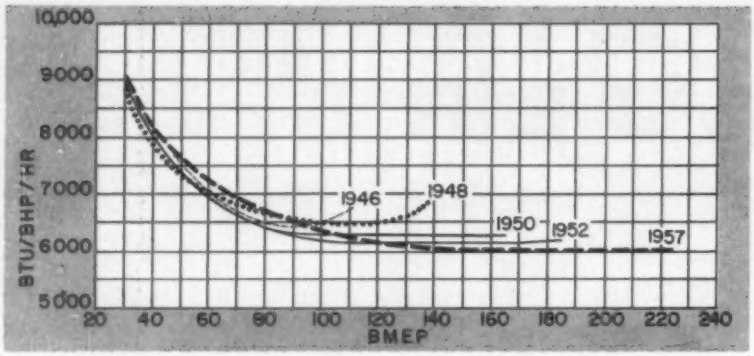


Fig. 1. Progress in development of supercharged 4-cycle gas engine. Shown are fuel economy, detonation-free pulling ability in bmep, and the time in years. Combustion air conditioning was applied in 1950, increased cooling was added in 1952, turbocooling in 1957

Gain in Engine Output and Fuel Economy Shown in Diesel Power Costs Today

Two new design principles—turbocharging and turbocooling—have been basically responsible for the present trend to higher hp per cylinder and more fuel economy for both 2-cycle and 4-cycle engines

BY W. R. CROOKS*

UNDOUBTEDLY the economic urge more than any other single factor has prompted all of us in the engine-building industry to achieve the developments witnessed in the power generating field over the past 20 years. For example, gas-burning engines had been in use for over 50 years before the first break through the compression barrier. In breaking through this barrier, in learning to burn gas at compression ratios of 11.5:1 instead of the conventional 4.5:1, phenomenal strides in increasing engine horsepower have been accomplished. And amazingly enough, fuel economies realized have initiated substantial savings in power costs.

Quick appraisal of what has been accomplished cost-wise is charted in Table I.

Perhaps the impact of the gains in power output and fuel savings can best be interpreted by a study of both construction and fuel costs of a typical compressor station. Such a station, for illustration, would have 10,000 hp and use various models of the same basic engine built over the past 12 years. Equipment and fuel costs of Table II are based on present-day prices.

Note from Table II that if 1947-model engines were used in this particular example, the 10,000-hp plant would cost $660,000 more than if the latest type of engines were used. Fuel bill for the 1947-model engines would be $33,500 greater.

To illustrate the trend that has been taking place, the chart of Fig. 1 plots critical engine load or output vs fuel economy over the past 12-year period.

Two Principles

Basic changes in engine design affecting the trend to higher horsepower per cylinder and improved fuel economy have been brought about by two fundamental principles developed by a concentrated research program at Cooper-Bessemer. These principles are: 1. turbocharging of both the 2-cycle and 4-cycle engines; 2. cooling of combustion air for the 2-cycle and the 4-cycle engines.

These two principles of necessity have been tied together, since turbocharging raises the temperature of combustion air considerably. Since higher specific loading and higher combustion air temperature tends to cause rough combustion, effective cooling of intake air is essential for higher specific output and lower specific fuel consumption.

It might be well to pause to review one important phase of the basic research work that preceded the most recent breakthrough in the turbocharging of engines, particularly the turbocharging of the 2-cycle engine. Some years ago, Battelle Memorial Institute was employed to work out a method of checking photographically the exact actions inside power cylinders during scavenging and the

*Chief Engineer, Development Division, Cooper-Bessemer Corp

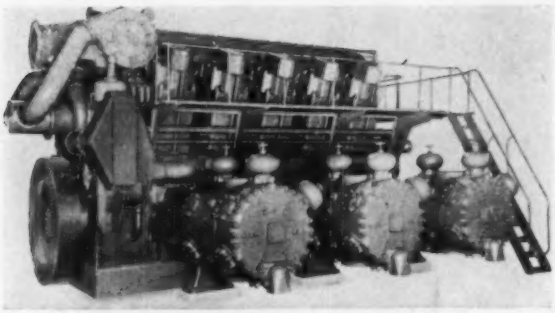
Table I. Phenomenal strides in increasing engine hp have been made, with resulting fuel economies

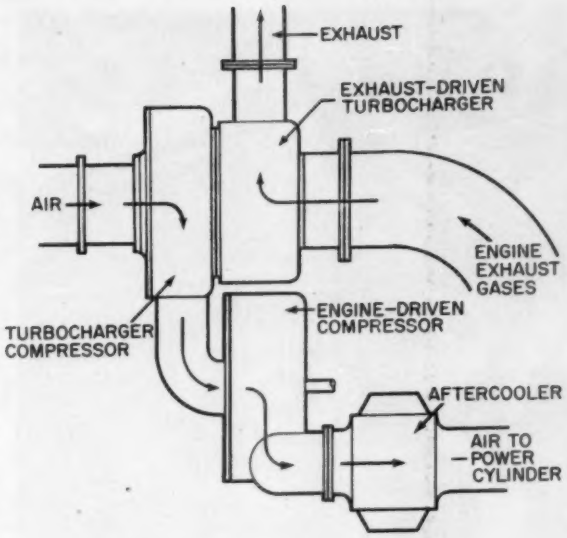
Engine Model	Former Rating BMEP —PSI	Present Rating BMEP —PSI	% Gain	% Gain In Fuel Saving
4-cycle diesel locomotive	130	195	50	10
4-cycle stationary or marine diesel	110	165	50	10
4-cycle stationary gas	70	165	136	40
2-cycle gas	62	110	77	30

Table II. Shown here is impact of gains in power output and fuel savings as seen in construction and fuel costs of typical compressor station

Date of Engine Model Production	HP	Cost 10,000 HP Comp. Station	Previous Model	Annual Fuel Cost Using 15¢/BTU.	Yearly Fuel Cost Saving Over Previous Model
1938–1947	1000	$2,480,000	$	$120,000	$
1947–1952	1100	2,350,000	130,000	100,000	20,000
1952–19—	1350	2,100,000	250,000	92,000	8000
1956–19—	1800	1,820,000	280,000	86,500	4500

Turbocharging and combustion air cooling used on 1956–19— engine model.





Turbocharging. Figs. 2 and 3 show a series turbocharging system. Photo shows Cooper-Bessemer Type GMWC V-angle, 2-cycle engine-driven compressor. Scavenging air and combustion air are compressed progressively in two stages (Fig. 3). A mechanically-driven compressor supplies air for scavenging and light operation. The turbocharger in turn supplies a constantly increasing amount of air required for combustion as engine becomes loaded

burning of gas fuel in the power stroke. Careful study of these high-speed photographs gave us a much clearer understanding of the process and enabled our designers to provide the effective scavenging.

Of major significance to the power industry has been the introduction of series turbocharging for 2-cycle engines. Much has already been said about this development. However, stated simply, for a little more than one-third additional fuel, an engine today of the same bore and stroke is able to develop twice the horsepower it put out a decade ago. This is being done with the same floor space. Fact is that it is no longer necessary to derate engines for altitude. Fuel consumption of 6900 Btu/hp-hr with 625 F cylinder exhaust temperatures pretty well tells the "economic" story.

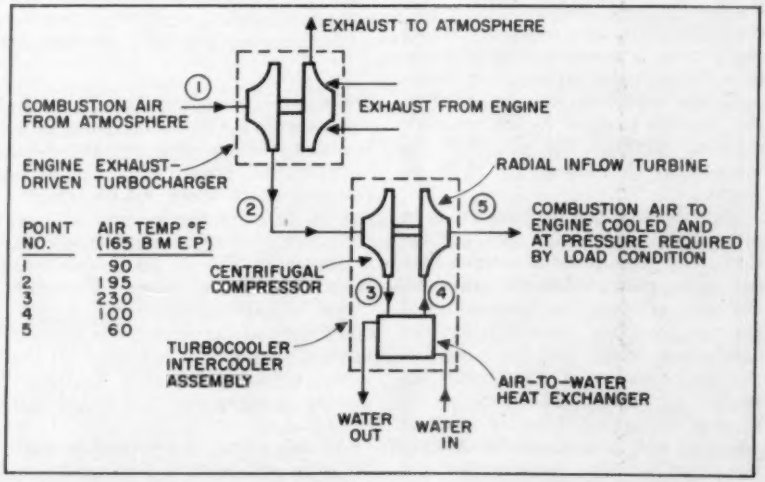
The series turbocharging system is so named because its constant pressure turbocharging system is arranged to operate in series with a mechanically-driven centrifugal scavenging blower. Such a system is shown in Figs. 2 and 3.

Briefly, in the series turbocharging system, scavenging air and combustion air are compressed progressively in two stages. Mechanically-driven compressor supplies air for scavenging and light operation. The turbocharger in turn supplies a constantly increasing amount of air required for combustion as the engine becomes loaded.

As it works out, the series turbocharging system, with its two stages of compression, is the only system where it is within the control of the engine manufacturer to have optimum air for combustion in the cylinder from fractional loads to considerable overload.

Now in regard to cooling of combustion air, one of the more noteworthy examples is in the development of the turbocooling principle used largely on 4-cycle engines. Fundamentally, turbocooling is a method for super-cooling combustion air. Through turbocooling, it has been possible to increase the output of the engine as much as 23 per cent, while reducing fuel consumption as much as 5 per cent.

In the past, air from the engine turbocharger had normally been throttled to the air manifold to maintain correct air-to-fuel ratio. Conventional practice had been to do this with the butterfly valves. Experience showed this practice a simple waste of energy with little, if any, effect on cooling the intake air. Introduction of the turbocooler, however, created a practical method of utilizing an abundant source of energy created by



Turbocooling. Fig. 4 is a schematic of turbocooler. Air enters turbocharger, is compressed by exhaust gas-driven centrifugal blower. Pressurized air at elevated temperature is directed to booster in turbocooler for second stage compression. Air is cooled by air-to-water intercooler before entering turbo-expander. As air expands through impeller, temperature drops 15 to 40 degrees

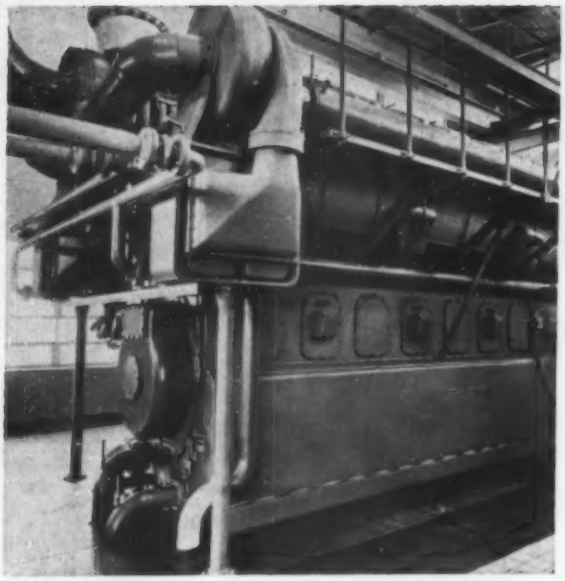


Fig. 5. Cooper-Bessemer Type LSV-16 supercharged spark-ignited gas engine equipped with turbocooler, rated 4380 hp

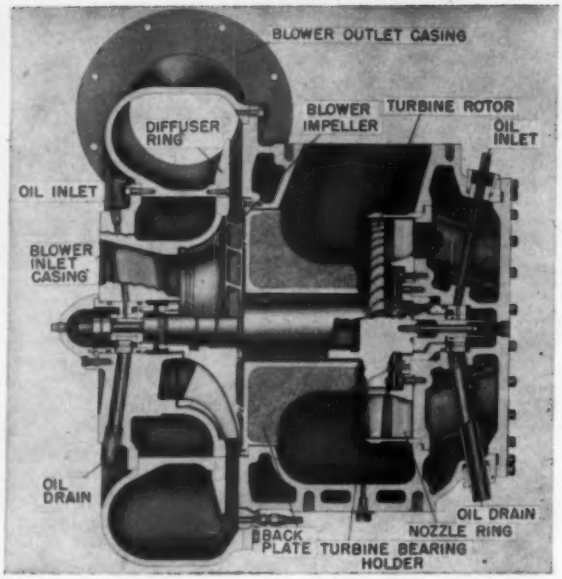


Fig. 6. Showing progress of engine intake air through booster stage of compression and through expander cooler

a pressure drop in the manifold, which would further cool the combustion air going to the engine cylinders.

Cooling cycle of the new development is shown in Fig. 4. In this system, filtered air enters the high-pressure turbocharger (1) and is compressed by the exhaust gas-driven centrifugal blower (2). The pressurized air at elevated temperature from compression is then directed to a booster (3) in the turbocooler for a second stage of compression.

As the air leaves the booster, its temperature and pressure are considerably higher than after the first stage of compression. This air is then cooled by an air-to-water intercooler (4) before entering a turbo-expander (5).

Since the pressure of the air entering the turbo-expander (5) is greater than the air intake requirements of the engine, a pressure drop is available through the expander to motivate the expander impeller causing the impeller to spin. As the same air expands through the impeller, its temperature is reduced by 15 to 40 degrees.

Net effect of the turbocooler is to provide the engine with cool combustion air. The more air or oxygen that can be concentrated in the cylinders, the more efficient the combustion of the fuel, and the more efficient the combustion of the fuel, the more fuel the engine can take. As a result, an engine equipped with turbocooling has the advantage of higher overload capacity with less danger of detonation and less Btu consumption per brake horsepower hour. See Figure 6.

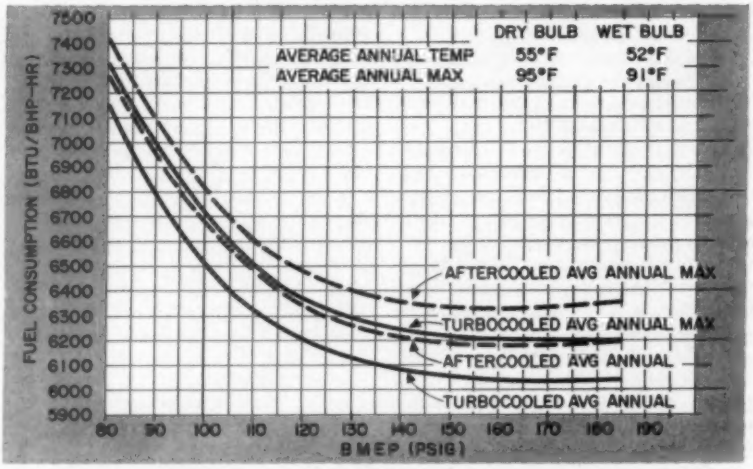


Fig. 7. Fuel consumption of a 4-cycle spark-ignited gas engine at various loads and using various combustion air conditioning systems. Engine was run at 327 rpm. Note added economy resulting from turbocooling compared to conventional aftercooling

In reality, the turbocooler is a bootstrap device with the expander impeller and booster impeller on a common shaft which allows the expander to drive the booster. An installation of the turbocooling system is shown in Fig 5. Fuel consumptions of a typical Cooper-Bessemer Type LSV-16 supercharged 4-cycle spark-ignited gas engine are charted against load in Fig. 7. Evident is the added economy initiated by turbocooling as compared to conventional aftercooling.

At this point, the economic challenge is still with the designer and developer of the modern gas or gas-diesel engine. Exact directions that future designs will take are still on the engine builders' drawing boards. But if the prime incentives of lower power costs prevail, and it is evident they will, future trends will continue towards higher outputs in power with further economies in fuel consumption.

THE END

For extra copies of this or any other articles in this issue, write The Editor, or jot the title that interests you on the return postcard inserted in this issue.

Water is our most valuable natural resource, yet we as a nation have been imprudent in our use of it. Misuse of surface streams has resulted in a serious situation of stream deterioration at a time when demand—and need—for quality water grows ever greater. This article takes stock of the situation as a whole and evaluates how far we have come in water pollution control, and what lies ahead

What Are We Doing to Protect Our Water Resources From Pollution?

By KENNETH S. WATSON*

NATIONAL REACTION to a national problem is the ratification of legislation to protect the welfare of the people. The states have responded to the water resource pollution problem with a wave of legislation. In fact 45 states have adopted comprehensive pollution control laws or programs to regulate water pollution.

Perhaps a more interesting and significant legislative trend, however, is in the interstate compact area. There is sound logic for such interstate commissions since pollution does not begin or end at state boundaries and thus can probably best be handled basin by basin as working entities. The compacts creating these agencies are ratified by the various states and by the Federal government. Therefore, such compacts create an intermediate level of governmental regulation between the State and Federal governments.

Five such compacts have now been in effect for a number of years. These interstate compacts are summarized in Table I.

Two other areas are working on the compact approach. The Great Lakes compact has been ratified by most of the eligible states and is in limited operation. The Tennessee River compact has been drafted and presented to the states for ratification.

The Federal government also has some responsibility in the stream pollution control field. Under public law 660 the Public Health Service is designated as the agency with Federal jurisdiction in this area. Under this law the Service can take action against a pollution offender in cases where a state cannot or will not take appropriate action. The Service also has the responsibility of arbitrating interstate problems where the two states involved cannot reach a solution.

Public law 660 indicates, however, that the enforcement authority rests primarily with the individual states. The Service is given specific research, coördination and grants-in-aid responsibilities.

Industry and municipality are both involved in water pollution control. An interesting and pioneering joint approach is being used by the Allegheny County Sanitary Authority in Pittsburgh. In this Authority, 71 municipalities and over 100 industries have agreed to treat their wastes in a common plant. An architect's rendering of the treatment plant for this $100,000,000 program is shown in Fig. 2.

This approach is significant since it should represent the most economical solution of the waste problems of an entire area. The collection system contains 63.5 miles of new intercepting sewers, and the primary treatment plant which has recently gone into operation has a daily capacity of 150,000,000 gallons.

Figure 3 is shown for a special reason. This shows the settling tanks and chlorination equipment of a polishing facility operated by the Sparrows Point Plant of Bethlehem Steel to permit this industry to use treated sewage from the City of Baltimore as a source of industrial water. This approach will be more and more used in the future as the nation's water requirements continue to pyramid.

Of course, industry as well as municipality is building and operating sewage treatment facilities, when necessary, in addition to industrial wastes treatment plants.

Where Do We Stand Now?

Population of the United States is often listed at 170 million. According to the U.S. Public Health Service, the nation's urban population is estimated at 112 million. About 100 million of this population is served by sewers at present. About 62 million of the 100 million people with sewers have adequate treatment. About 18 million have inadequate treatment, and 20 million have no treatment at all.

Since none of the treatment plants does a 100 per cent correction job, it is estimated that on a BOD basis (BOD means biochemical oxygen demand, or the demand of the sewage for oxygen), the treated and untreated sewage flowing into the nation's streams at present has a population equivalent of 55 million. (The term population equivalent, P.E., merely means the equivalent un-

* Consultant, Water Management and Waste Control, General Electric Co

Table I. Interstate pollution control compacts. Two more are now being formed

Item	Ohio	Potomac	Interstate **	Delaware	New England
Number signatory states	8	5	3	4	7
Effective Date	1948	1941	1936	1936	1947
Commissioners per State	3	3	5	5	5
Area — Sq Mi	154,185	14,500	1,500*	12,757	65,000
Population 1950 Census	17,100,294	3,000,000	11,000,000	5,161,700	9,200,000

* Miles of shoreline

** New York, New Jersey, Connecticut

1

Industry and municipality are both involved in water pollution control . . .

1. Small sanitary sewage plant at GE's Irmo, S.C., plant. This secondary treatment system consists of an Imhoff tank and intermittent sand beds. **2.** This is the Allegheny County Sanitary Authority's new plant in Pittsburgh. It will treat wastes from 71 municipalities and over 100 industries. **3.** This plant at Bethlehem Steel, Sparrows Point, Md, enables that industry to use treated city sewage effluent as industrial water—an approach which will be more and more used as the nation's water requirements continue to pyramid. **4.** Waste treatment plant at GE's Appliance Park in Louisville, Ky, discharges pretreated wastes into the municipal sewer system

treated sewage load originating with the number of people listed in each case.)

It can therefore be seen that the nation's sanitary sewage pollution problem is at present being reduced 45 per cent by treatment efforts.

Table II assumes that the sanitary sewage population equivalent flowing into the nation's streams should be reduced to 36 million. The population sewered will grow to 180 million people in 1985, an increase of 82 per cent over the present situation.

In order to hold the population equivalent in the streams to 36 million in 1985, the treatment efficiency would need to be 80 per cent rather than the 45 per cent prevailing today.

In order to maintain a 36 million population equivalent, 120 per cent of present expenditures must be made in 1965 and the intervening years between 1959 and 1965, 70 per cent in 1973 and intervening years, and 81 per cent in 1985 and intervening years.

Table III shows that there are 7518 sewage treatment plants in operation in the United States today. These plants represent an investment of $8.9 billion in 1955 dollars. About 1832 of these plants require modernization or additions. It is estimated that 3522 additional treatment plants are required to bring the sanitary sewage problem reasonably under control. These plants would have a cost of $1.40 billion. No sewer additions or modernizations are included in this total.

Expenditures in 1955 dollars for sewers and sewage treatment for each year during the period 1952 through 1958 ranged from $420 million to $629 million. A total of $629 million was spent during the maximum year 1956, $338 million of it going for treatment plants.

It is significant that the Federal grants-in-aid program for sewage treatment works under public law 660 has been in effect since July 1, 1956. The Public Health Service reports that the level of construction has been appreciably higher each year since the program was launched.

For instance, the average construction level for sewage treatment facilities was $222 million for the years 1952–1956. With the grants-in-aid program in effect, construction was at a $351 million level in 1957 and $389 million was spent in 1958.

Under public law 660, $50 million is authorized annually. Over the past two years $7.80 was spent for sewage treatment by the local communities for each dollar advanced in matching funds by the Federal government.

Summing Up

1. There are at present 7518 sewage treatment plants in operation in the United States. These plants represent an investment of 8.9 billion 1955 dollars. About 3522 additional treatment plants are required to bring the sewage problem reasonably under control. These plants will have

Table II. Pollution trends in municipal sewage. It is assumed that the sanitary sewage P.E. should be reduced to 36 million

Feb, 1958

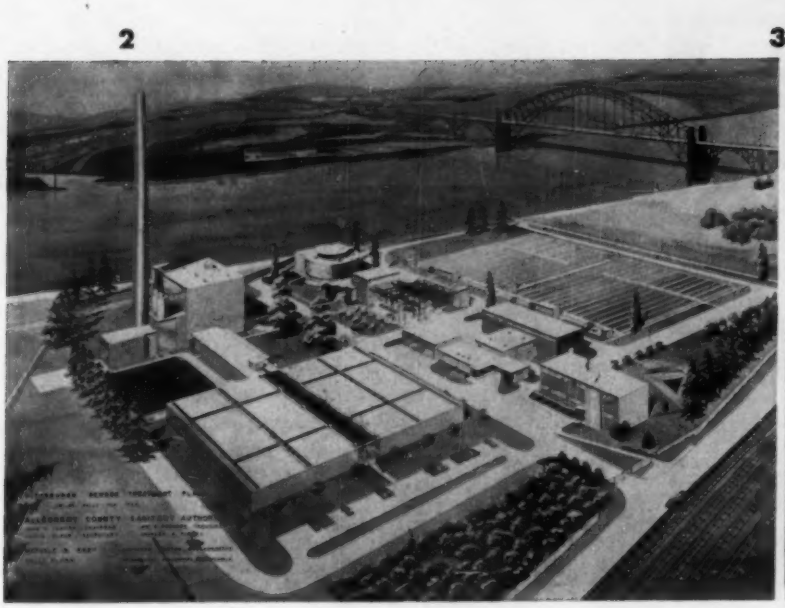
	1957	1965	1973	1985
Sewered population in millions	99	117	140	180
Increase in sewered population %	—	18	41	82
Treatment efficiency to attain 36 million P.E. residual pollution %	64	69	74	80
Increase in total annual expenditures to attain 36 million P.E. residual pollution %	—	120	70	81

Figures from the U.S. Public Health Service

Table III. Construction of sewage treatment plants. These represent an investment of $8.9 billion in 1955 dollars

Number of plants — 1957	7518
Number of plants requiring modernization or additions — 1957	1832
Total investment in facilities — 1920–58	$8.90 billion ($1955)
Additional plants required — 1957	3522
Estimated cost new plants	$1.40 billion ($1957)

Figures from the U.S. Public Health Service



2

3

4

a cost of approximately $1.40 billion.

2. It appears doubtful that merely holding the line on the sanitary sewage pollution load as it exists today will permit the nation's streams to perform the vital future services expected of them. The Public Health Service estimates that the population equivalent of 55 million now discharging into the streams must be reduced to 36 million.

3. In order to achieve and maintain a discharge population equivalent of 36 million, the Service estimated in early 1958 that 120 per cent of the expenditures for that year must be made for each year through 1965. Since $389 million was spent in 1958, the projected expenditures for the next seven years to meet the objective amount to $465 million annually. As of January 1, 1959, the Service made another estimate that $575 million should be spent annually for the next eight years to meet our current backlog and population growth needs. It should be realized that the figures quoted are for sewage treatment plants alone, and thus they do not cover sewer additions and modernization.

4. As a result of reviewing relationships, it would appear that the expenditures for sewers alone for the next seven or eight years should approach a figure in the magnitude of $400 million each year if the population equivalent objective of 36 million is to be reached and maintained.

5. The Federal grants-in-aid program for stimulating the construction of sewage treatment plants being carried out under the jurisdiction of the Public Health Service is paying dividends.

6. A review of progress in the Ohio River Valley Water Sanitation compact area indicates that industry is at least keeping pace with municipality in providing waste treatment. About 54 per cent of the industries in the basin have waste treatment, compared to 34 per cent of the cities. It should be pointed out that the numbers of cities or industries with waste treatment facilities does not tell the complete story of pollution control because they make no allowance for variations in loads. THE END

Table IV. Municipal sewage treatment facilities in the Ohio River Basin. 34% of the cities have adequate treatment

July 1, 1958

States	Number Municipalities	Adequate Treatment	% Adequate Treatment
Illinois	57	41	72.0
Indiana	275	111	40.5
Kentucky	194	114	58.7
New York	23	5	21.7
Ohio	443	195	44.0
Pennsylvania	322	69	21.4
Virginia	88	23	26.2
West Virginia	172	23	13.2
TOTALS	1574	581	34.2

From 10th Report of the Ohio River Valley Water Sanitation Commission

Table V. The score for industrial waste control in the Ohio River basin. 54% of the plants have satisfactory treatment

July 1, 1958

States	Total Industries	Adequate Treatment	% Adequate Treatment
Illinois	15	7	46.6
Indiana	211	168	79.5
Kentucky	196	118	60.0
New York	48	14	29.2
Ohio	406	244	60.0
Pennsylvania	250	96	38.4
Virginia	40	20	50.0
West Virginia	293	121	41.2
TOTALS	1459	788	54.0

From 10th Report of the Ohio River Valley Water Sanitation Commission

In a continuation of a series on Air Compressors, this author explains some simple rules on maintenance. A daily log is the answer in predicting troubles before they become serious. Automatic shutdown devices serve a useful purpose, can become inoperative

Here Are Simple Rules

By DON LOHSE *

Compressor down-time means money, and you can prevent breakdown or major overhaul by following a simple, yet effective, preventive maintenance program. Such a program, by eliminating extensive down-time, means savings in money and time, with bigger profits

ANY PROGRAM is only as good as the people who administer it. This is particularly true in a power plant compressor operation, where uninterrupted functioning of the machine is an absolute must. Some one person should be completely familiar with the operation of the machine, so he can spot trouble as it starts to happen, much as an experienced driver gets the *feel* of his car and immediately notices any deviation from normal.

Good housekeeping is an essential in preventive maintenance. Experience has shown that by taking a few minutes each day to wipe the machine with a cloth, years can be added to the life of the machine. If dirt and other matter build up on the outside of the machine, it can cover mechanical defects, such as a loosened bolt or connection. A simple adjustment with a wrench or screwdriver at this stage can save real money later.

After the daily cleaning of the machine, entries should be made in the operating log. Keeping a record of

* Application Engineer, Joy Mfg Co

JOY COMPRESSOR OPERATING LOG SHEET NO.

UNIT NO. _____ SIZE _____ WEEK ENDING _____
MFG. _____ SERIAL NO. _____ TOTAL HOURS TO DATE _____
CLASS _____ DRIVE _____ MAINTENANCE SUP. _____

DATE		COMPRESSOR							AFTERCOOLER TEMPERATURE				REMARKS
		PRESSURE			TEMPERATURE								
					AIR		WATER		AIR		WATER		
	TER	I.C.	BAR.	OIL	IN	OUT	IN	OUT	IN	OUT	IN	OUT	

MAINTENANCE RECORD

DATE	TOTAL HOURS	CRANK. OIL	LUBR OIL	MISCELLANEOUS REPAIRS, CHANGES, ETC.	

USE _____ USE _____ INSPECT VALVES AT _____ CLEAN AIR FILTER _____
CHANGE AT _____

Fig. 1. Key to compressor maintenance is a daily operating log, which is easy to keep but will show up trouble when it is just beginning. By serving as a check list for maintenance procedures, it helps to keep many troubles from ever getting a start

for Compressor Maintenance

pressures and temperatures will reveal much about the operation of the compressor; not so much in values themselves, but because any abrupt change in value usually can be traced to a part or component that needs attention.

An alert operator, with the help of an operating log, will be able to detect a change in intercooler pressure readings, for example. If such a pressure change was traced to a broken valve, the machine could be shut down, the broken valve replaced, and the unit put back on the line before any noticeable drop in pressure is experienced. Such a chain of events would not, in most instances, disrupt the operation of your plant; however, without a record of what is normal operation for the unit, it is unlikely that such troubles would be noticed until the damage was far beyond the minor repair stage.

Using the Log Sheet

Part of the operating log sheet should be used for a maintenance record to show the amounts of crankcase and lubricator oil added, when and where parts are replaced, and instructions to the operator as to when to inspect valves, when to clean air filter, and grade of lubricant to use. Providing the operator with an operating log sheet will permit the inclusion of simple instructions for servicing the machine.

Many compressor owners and operators utilize safety devices, such as shutdown switches and alarms, to indicate unusual pressure and temperature situations in the compressor and its associated piping. Many compressors have as standard equipment a low-oil-pressure shutdown switch, which, in the event of low oil pressure, will stop the compressor before major damage is done.

Additional switches are sometimes added, either to stop the machine or sound an alarm, or both, in the event of higher-than-normal discharge air temperature, an abrupt change in intercooler pressure, cooling water failure, or low oil level in the lubricator. Such devices are fine, but they must be frequently checked. A warning light that is burned out, or a horn that doesn't sound, is worse than no light or no horn at all. Include on the compressor check list the procedure for checking the safety devices so that they will do the job when they are needed.

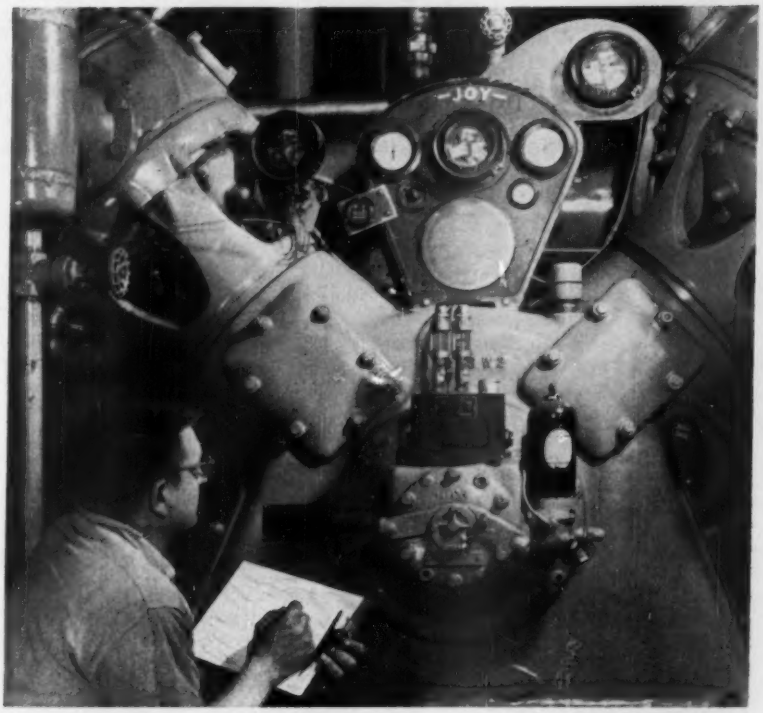


Fig. 2. It's regular inspection time as operator checks off on his operating log

Pop safety (or relief) valves are to be found wherever compressors are in operation, also. These devices are almost foolproof, but *almost* is not good enough; so include them on the check list, to make sure that they are functioning properly.

While attention to cleanliness and observation of pressures (through the operating log) prevents most trouble, there are several other points that can be checked frequently to prevent serious or prolonged interruption.

One important practice is to make a visual inspection of the valves every 1000 hours. It takes very little time, but if inspection reveals a cracked or chipped valve, the time will be well spent. If the damage occurs, make sure that the valve seat is in good condition, or the replacement valve will soon fail.

Automatic condensate traps, on the intercooler, are items on compressors that should be serviced but which are frequently overlooked. Many operators are of the mistaken belief that these devices are self-cleaning, and require no attention. Most traps are easy to clean, and so doing will prevent malfunctioning and damage to the compressor. The same type of service should be applied to the trap on the moisture separator of the aftercooler.

In summary, profitable preventive maintenance of industrial air compressors requires:

1. One man responsible and familiar with machine; 2. good housekeeping; 3. daily readings of gages and thermometers and recording readings on an operating log; 4. visual inspection of valves every 1000 hours; and 5. cleaning of automatic condensate trap frequently.

Preventive maintenance of air compressors can mean, as it has meant to some firms, daily operation for over five years, without a breakdown or major overhaul. Preventive maintenance can accomplish the same for you. THE END

We Monitor Silica Automatically In 2600-psig Boilers

In modern h-p h-t boilers, tight rein must be kept on silica and other contaminants in the boiler water in order to prevent boiler and turbine deposits. Here is how Niagara Mohawk does it by completely automatic chemical analysis, a forward step in power plant automation

By THOMAS FINNEGAN *

SILICA, which had been a mildly objectionable constituent of boiler deposit when boiler pressures were low, became a major nuisance in the power plant when pressures increased above about 1000 psig. It appeared on turbine blades as a hard coating of quartz or amorphous silica and caused loss of capacity and efficiency. To remove it, the parts had to be sand- or fly-ash-blasted.

Only practical way that has been found to prevent silica deposits in the turbine is to eliminate them as far as possible from the steam. The concentration in the steam depends upon that in the boiler water and, as the boiler pressure increases, diminishing quantities can be tolerated in the boiler water if the permissible concentration in the steam is not to be exceeded.

The relationship is shown in the curves of Fig. 1. They indicate that, if 0.02 ppm (parts per million) of silica is a permissible quantity in the steam, the boiler water may contain 5 ppm when the pressure is about 1350 psig, but may not exceed about 0.3 ppm when the pressure is 2600 psig.

The curves explain why it had been thought that silica did not carry over at pressures below 1000 psig. It carries over but, at 900 psig, for instance, about 30 ppm would be necessary in the boiler water to give 0.02 ppm in the steam.

When a pair of 2600-psig boilers was put in service recently, it was decided to control the silica content of the steam by monitoring the silica content of the boiler water, taking advantage of the relationship between the silica in the steam and that in the boiler water shown in Fig. 1. Sampling is easier; the magnitude of the result is higher, making the determination less delicate; and operating control is facilitated. If the boiler water silica is higher than that permissible at 2600 psig, the pressure is dropped to that at which that concentration of silica can be tolerated. The boiler is blown down and, as the silica concentration drops, the pressure is increased.

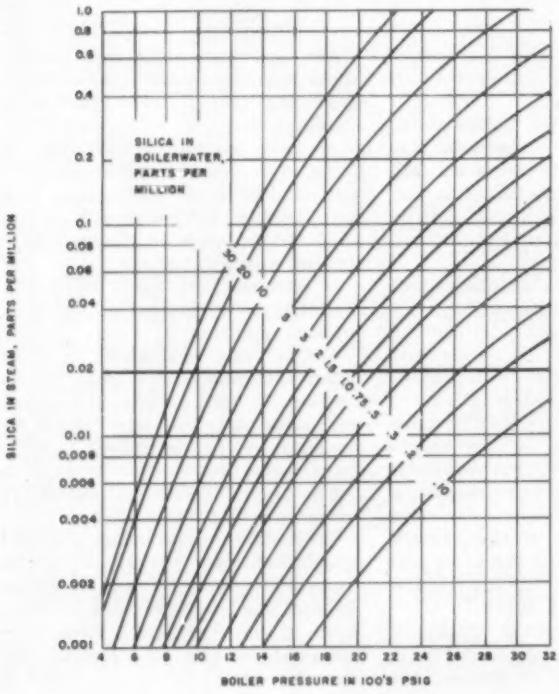


Fig. 1. Curves showing calculated relationship between silica in boiler water, silica in steam, and boiler pressure. Curves by A. B. Sisson, Commonwealth Edison Co. from data of F. G. Straub, University of Illinois. Curves are reproduced with the permission of Mr. Sisson

How Instrument Is Used

Figure 2 is the operating curve that was prepared from Fig. 1. It shows the boiler pressures and boiler water silica for a silica steam content of 0.02 ppm.

Monitoring is done by means of the Technicon Autoanalyzer. This instrument in effect performs the manipulations of the conventional silica analyses by means of a group of "modules," through which a continuous sample and the required reagents pass.

Use of the Autoanalyzer for the determination of silica, as well as other materials in the power plant, has been discussed by A. Ferrari and E. Catanzaro. Ordinarily the parts, including the recorder, are set on a laboratory bench. On occasion, however, they have been mounted in a cabinet. A cabinet is used in the present case, with automatic valving to permit sampling of both boilers. The record is telemetered into the control room. Figure 3 shows the Autoanalyzer assembly in the cabinet.

While it would have been ideal to have two completely separate records, one for each boiler, this was not practical. Instead, one boiler is sampled for 15 min and the result recorded. The instrument is then standardized, and the other boiler is sampled. The record appears as a

* Chemical Engineer, Niagara Mohawk Power Corp

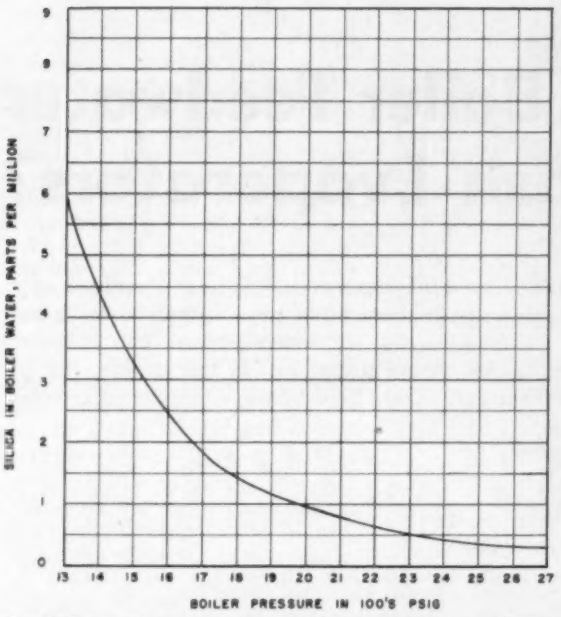


Fig. 2. Operating curve, prepared from Fig. 1, showing boiler water silica concentration producing 0.02 ppm in steam

Fig. 3. View of the components of the Autoanalyzer in cabinet, as used for silica analysis on two 2600-psig boilers

broken line, the sections of which are easily attributable to the proper boiler.

There have been problems. The reagent consumption was high because the nature of the technique is the performance of a great number of analyses. Changing to smaller diameter tubes on the manifold that draws the sample and reagents into the analyzer alleviated this. Although the Autoanalyzer has worked very well on a single sampling point, there have been certain mechanical difficulties on application to 2-point sampling. The troubles have not been abnormal for a new type of instrument, and a similar installation is being made at another station which has two boilers of the same type.

The Autoanalyzer has been valuable in monitoring silica when a boiler is being put on the line. Although the feedwater piping was thoroughly cleaned before the original start-up, silica may increase in the boiler water at these times, presumably from the disturbance of some small accumulation that escaped the cleaning process. While the total amount may be less than 1 ppm and entirely acceptable by older standards, it is too high for boilers operating at these pressures. The instrument has also helped to detect small condenser leaks that cannot be tolerated, because these boilers are not receiving any treatment to protect them against scale. While it might not be absolutely necessary to have a record of silica during long periods of steady operation, when the amount in the boiler remains about the same, it is assuring to the operators to know that the concentration is below that at which danger of turbine deposit may be expected to occur. THE END

How the Technicon Autoanalyzer Works

(Editorial Note)

THE TECHNICON AUTOANALYZER shown in Fig. 3 of the above article is manufactured by Technicon Controls Corp. Its completely automatic operation is described in detail by A. Ferrari and E. Catanzaro in a 1959 American Power Conference paper.

The assembly, shown above, consists of these components:

1. Automatic Sampling Unit
2. Proportioning Pump
3. Constant Temperature Dialyzer
4. Heating Bath
5. Dual Beam Ratio Recording Calorimeter
6. Ratio Type Recording Unit and Voltage Regulator Unit

For automatic silica analysis, the sample, continuously proportioned at 2.5 ml per min, is joined with 0.6 ml of 0.2 N hydrochloric acid, augmented by air and mixed in a mixing coil. Into this stream is introduced 1.2 ml per min of 1 per cent ammonium molybdate.

Combined streams are then mixed and sent to a time-delay coil for development of silicomolybdate. On emerging, the stream is next joined by a 0.8 ml per min solution of 5 per cent oxalic acid, mixed, and sent through another time-delay coil for destruction of any phosphomolybdate. After leaving this coil, the stream is joined by 1.2 ml per min of aminonaphthal sulfonic acid reagent. Streams are mixed, sent through another time-delay coil for final color development, then to the colorimeter where the absorbence is measured; and the recorder shows this measurement.

By suitable modifications, the analyzer can automatically measure phosphate. Other determinations being investigated include those for iron, copper, dissolved oxygen and other constituents.

Why Not . . . Boiler Feedwater From Flash Evaporators?

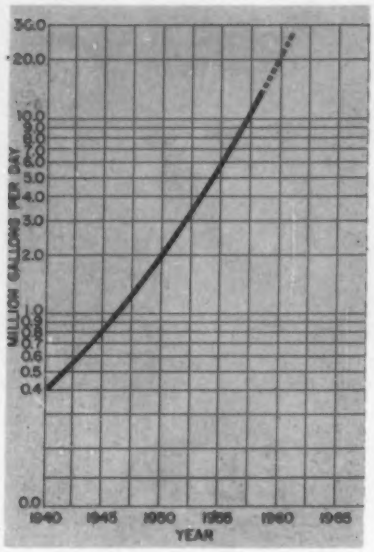


Fig. 1. Curve shows installed-capacity growth of land-based evaporators

Purification of water by flash evaporation has been standard practice for years. Marine applications have been successful for a long time, and have furnished data for investigations into a source of high-purity water for steam plant use. In this article, the authors, Messrs. Stalcup and Coit, give some valuable information

By E. F. STALCUP and R. L. COIT *

INTEREST IN PURIFICATION of water has increased rapidly during the past ten years, and the technology has advanced in many areas. The Office of Saline Water (in the Interior Department) continues to support research and development in the demineralization of saline waters by many techniques. These include freezing, ion-exchange, electrodialysis, and several distillation techniques.

In terms of *installed capacity*, distillation units far exceed any of the other processes. Total installed capacity of land-based sea-water evaporators is shown in Fig. 1, which indicates the rapid increase in the use of this process. An appreciable portion of the installed distillation capacity is of the older submerged-tube design, but the additions that are being made consist largely of multi-stage flash-type units.

Successful operation of multi-stage flash evaporators, for producing potable water from sea water, led to the investigation of flash-type units for producing high-purity boiler make-up in modern power plants and ultra-pure water for use in industrial processes.

* Heat Transfer Apparatus Dept., Westinghouse Electric Corp

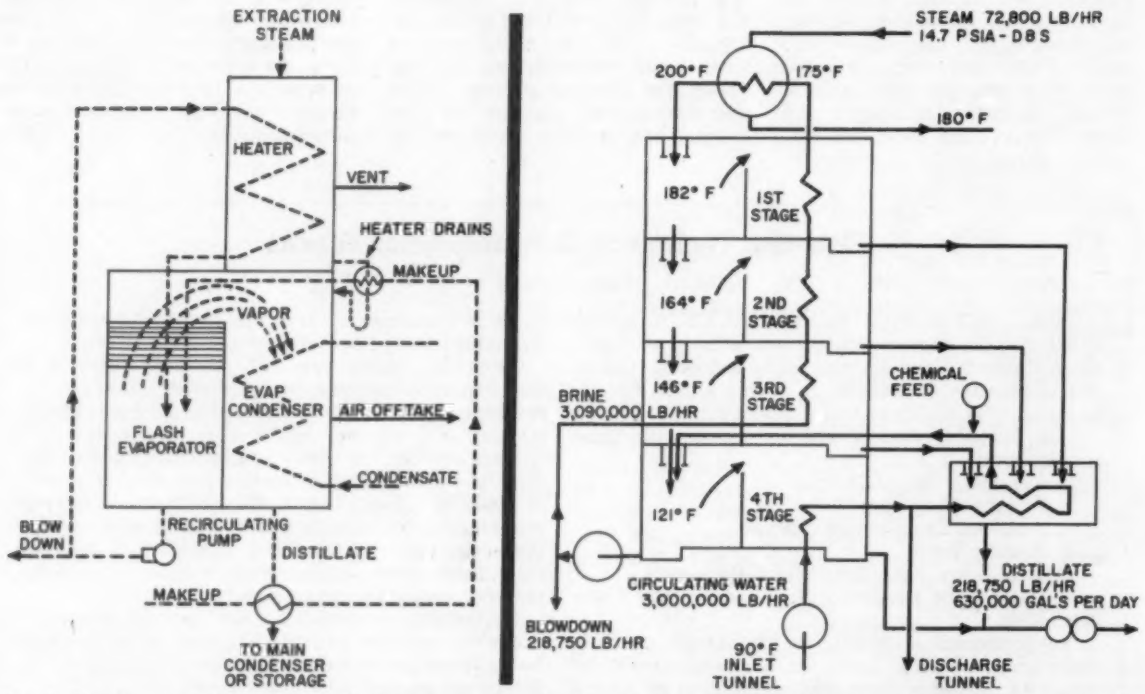


Fig. 2. Drawing on left shows simplified diagram of single-stage flash evaporator. At right: multi-stage evaporator unit

In principle, flash evaporation is a relatively simple process. Basically, it consists of spraying warm (or hot) water, under pressure, into a chamber that is at a lower pressure and temperature. A portion of the water *flashes* into vapor and then is condensed. The flashing results from the difference in the heat storage ability of the water, under the higher and lower pressures. The vapor is formed almost simultaneously with the disintegration of the liquid mass.

A simplified flow diagram of a single-stage flash evaporator is shown in Fig. 2. Make-up water enters the unit through heat exchangers, which uitlize energy from the distillate and the steam heater drains. This make-up is deaerated as it joins the recirculating "brine," which is pumped through the brine heater, where low-pressure steam heats the brine.

Deaeration of the make-up decreases the corrosiveness of the brine and enables the use of carbon steel shells in the unit, even for sea-water applications. The heated brine then passes through a restriction into the flash chamber, which exists at a lower pressure, the pressure being maintained by the evaporator condenser.

Achieving Distillate Purity

The evaporator condenser condenses the distillate by transferring the latent heat of the flashed vapor to colder raw-water. The desired distillate purity is achieved by passing the flashed vapor through appropriate steam separation devices. Unit shown in Fig. 2 is a single-stage device, which would produce slightly less than one pound of distillate per pound of low-pressure steam supplied to the brine heater. It would, therefore, result in an uneconomic installation for the production of large quantities of water.

Multi-staging can be used to increase the ratio of distillate produced to steam supplied, as shown in Fig. 2. This diagram shows one of the four 640,000-gpd units that have been in operation in Kuwait, on the Arabian Peninsula, for over two years.

In this unit, hot brine (containing 84,000-ppm total dissolved solids) enters the heater at the top, then flows to the first-stage flash chamber. A portion of the water is flashed here, and the remainder flows to the second stage, which is at somewhat lower pressure and temperature than the first stage. More water is evaporated in the second stage, and still more in the third stage.

In each of the three stages, the water used in the condensers is recirculated. The water remaining after the fourth stage of flashing is supplemented by make-up water, then passes successively up through the condensers of the third, second, and first stages in that order, picking up heat as it goes. The final heating is supplied by steam at the top, or beginning, of the cycle.

The fourth-stage condenser is supplied with raw sea water; distilled water flows from the fourth stage to storage facilities.

Only four stages were used, since fuel costs in this particular area are very low, due to the availability of waste natural gas from adjoining oil fields.

Single-stage submerged-tube evaporators, such as shown schematically in Fig. 3, have been used for many years to produce boiler make-up for steam power plants. Extraction steam is passed through a heating coil, to evaporate raw water and produce pure vapor, which is normally discharged into a deaerator or lower-pressure heater. The operation of the submerged-tube unit results in a decrease in the steam flow through the turbine — between the third and second extraction points, thereby decreasing the work done by the turbine.

A flash evaporator can be integrated into the regenerative feedheating cycle, as shown in Fig. 4. Since the heat transfer, both in the brine heater and the evaporator condenser, involves condensing rather than boiling, low-temperature differences can be employed and high

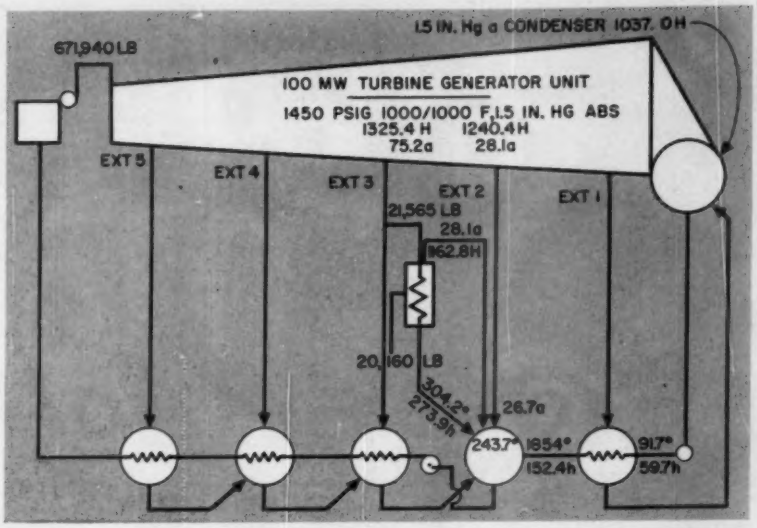


Fig. 3. Diagram of single-stage, submerged-tube evaporator in turbine steam cycle

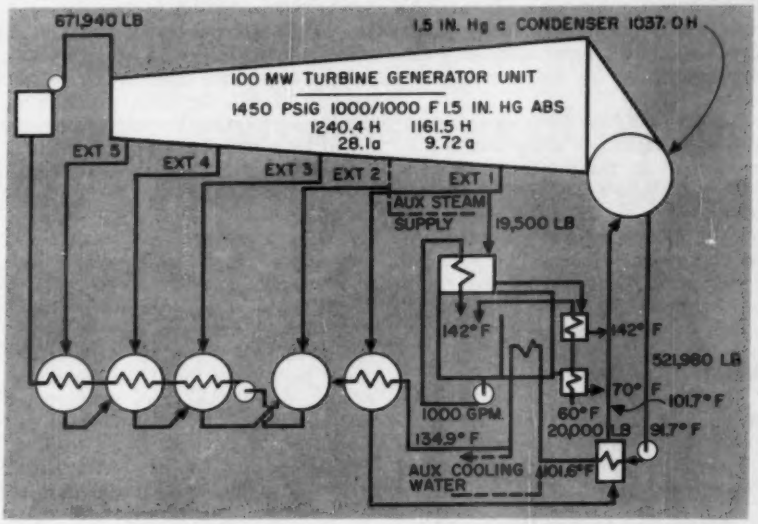


Fig. 4. Typical installation of a multi-stage submerged-tube type of evaporator

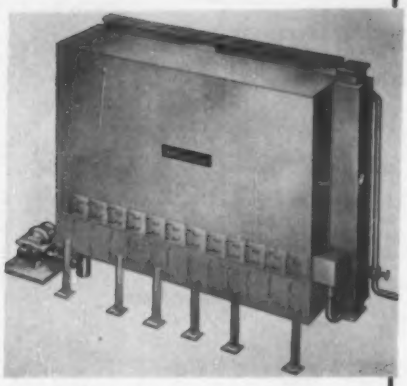


Fig. 5. Philadelphia Electric Co will install this evaporator unit this year

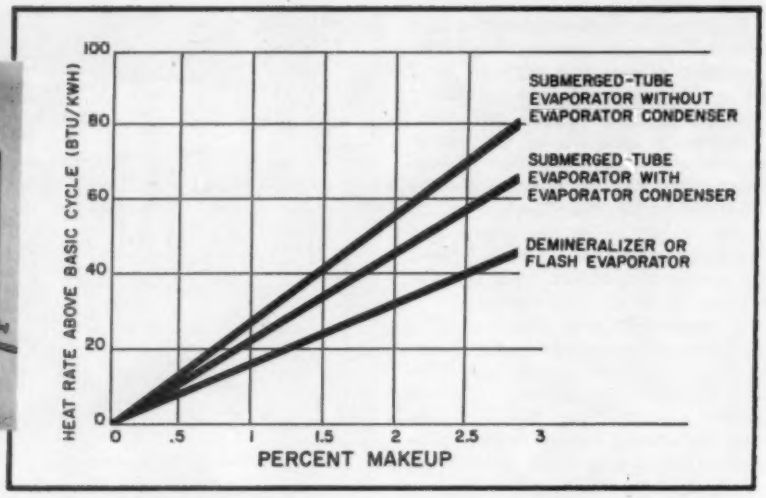


Fig. 6. Graph showing effect of make-up on heat rate of a typical plant cycle

heat-transfer rates maintained. Advances in the design of steam-separation equipment have also enabled the operation of sub-atmospheric evaporators.

Location of the flash evaporator, as shown, results in a significant improvement in the turbine-generator heat rate, since all of the energy associated with the steam extracted by the flash evaporator is returned to the regenerative cycle with no degradation. The evaporator could be thought of as a *zero-point* heater, which precedes the first low-pressure heater and receives steam in parallel with the first heater.

Sufficient extraction steam is taken from the turbine by the flash evaporator (and the first heater) to provide the proper temperature-rises of the condensate.

Effects of Adding Make-up

The introduction of make-up into a regenerative cycle increases the cycle heat-rate, since additional steam must be extracted to heat the make-up, from its entry temperature up to the final feed temperature. The effect of adding various amounts of make-up by several processes to a typical large turbine-generator cycle, is shown in Fig. 6.

For example, at one per cent make-up, the turbine heat-rate is increased approximately 27 Btu per kwh, when the make-up is provided by a submerged-tube evaporator — without the use of an evaporator condenser. If the same one per cent make-up is produced by either a demineralizer or a flash evaporator (located as shown in Fig. 4), the increase in heat-rate is approximately 16 Btu per kwh.

Differential effect on heat rate at one per cent make-up is thus approximately 16 Btu per kwh.

Differential effect on heat rate at one per cent make-up is thus approximately 11 Btu per kwh, which is a significant improvement, when evaluated for a large central-station unit. The differential heat-rate between the submerged-tube and flash evaporators depends, to a slight degree, on the cycle arrangement, steam conditions, and unit size. An evaluation of many cycles has shown the values given in Fig. 4 to be representative.

Additional heat-rate improvement can often be achieved by discharging boiler blow-down into the flash evaporator. Since the flash evaporator operates at a low temperature level (usually 110 to 125 F), a greater percentage of the energy in the boiler blow-down can be recovered than if if were admitted to the shell of a conventional submerged-tube evaporator, which operates at a higher pressure level.

An additional area of application of the flash evaporator is to provide high-purity water for older power stations than are operating as peaking units, and are unable to produce the required quantities of make-up.

New Multi-Stage Unit

An artist's conception of a unit that is to be installed by Philadelphia Electric Co in 1960 is shown in Fig. 5. This 12-stage vertical unit will supply 50,000 pounds per hour of make-up, to supplement the available submerged-tube evaporator capacity. A multi-stage unit was chosen, since high-pressure steam will be used for the heat source, and the unit is not incorporated into the regenerative cycle. The process diagram is an adaptation of that used for the Kuwait units, Fig. 2, with the final stage heat rejection to river water.

A logical extension of the application to older power plants is to use multi-stage flash evaporators for the production of large quantities of high-purity water for industrial processes. In many chemical and petroleum processes, where the percentage make-up is very high, a multi-stage flash evaporator is often the most economical means of producing the desired high-purity make-up.

Summary

Flash evaporators can be used to produce pure water in any desired quantity from sea water, brackish water, or fresh water.

Single-stage flash evaporators (incorporated into steam power plant cycles) effect an improvement in heat-rate over cycles using submerged-tube evaporators. The development of flash evaporators has progressed rapidly, and at present this apparatus has several significant advantages. The equipment does not require descaling, whether it is fed with fresh water or sea water.

Distillate is of extremely high purity — 0.05 ppm total solids from fresh-water feed (concentrated to 3000 ppm), or 0.25 ppm from salt-water feed (concentrated to 70,000 ppm); also, chemical treatment can be incorporated into the cycle, where necessary. THE END

Want Extra Pages of Articles?

Don't tear up your copy! We'll be happy to furnish you extra pages of articles. Just write the Editor on your letterhead or use the enclosed post card, and jot down the title that interested you.

Fig. 1. Transmitter (r) measures a pressure of 2500 psi on main steam drum. Behind operator is sight column with TV camera which transmits this to screen in the control room

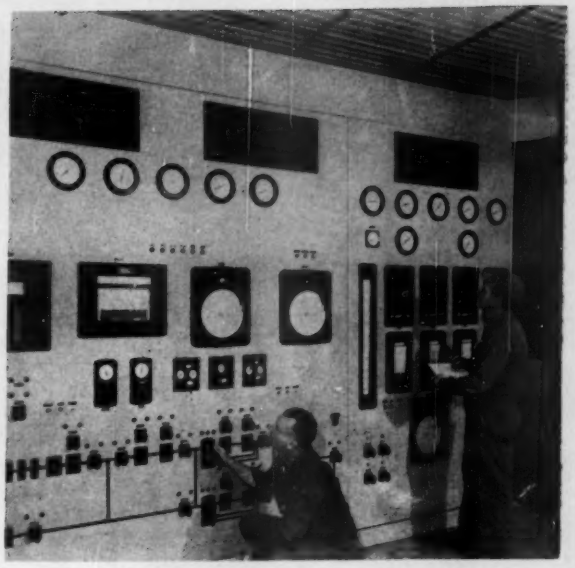


Fig. 2. In control room, showing instruments for Unit 1 of Schuylkill Station. Above the recorders are the round case pneumatic receivers which indicate the transmitted pressures

Pneumatic Transmission Simplifies Plant Pressures Measurement

WHEN Philadelphia Electric Co added a new 185,000-kw unit at their Schuylkill Power Station, they chose pneumatic transmission systems to indicate plant operating pressures both locally and on the centralized control panel. In all, there are 21 such systems, each comprising an indicating pneumatic transmitter, Fig. 1, connected to a panel-mounted dial indicator, Fig. 2.

Put into operation late in 1958, the new Unit 1 replaced three older units installed in 1911 and 1913, bringing the station's total generating capacity to 325,000 kw. In the older units, the practice of pressure measurement was to pipe the pressure directly to panel-mounted gages in the control room, and to have a second, locally-mounted gage, connected in parallel, as a guide to the operators.

In the new unit, the pneumatic transmission systems use only low-pressure air (3 to 15 psi) to transmit and indicate the pressures in the control room. Thus they keep system pressures, some as high as 3000 psi, out of the control room, where leaks or ruptures could be harmful. In addition, the transmission systems eliminate relatively costly runs of high-pressure piping. Dial indicator on the pressure transmitter replaces the duplicate, separate gage used formerly.

Figure 3 shows schematically the pneumatic transmission system used by Philadelphia Electric Co. Both indicating transmitters and dial indicating receivers were supplied by U. S. Gauge Division, American Machine & Metals, Inc.

Pressure from the equipment or line is piped to the locally-mounted transmitter, which contains a Type-316 stainless steel, Bourdon tube, spring element. Through suitable linkage, the Bourdon tube moves the indicating pointer on the transmitter's 3½-in. dial.

Tube movement is also converted into a pneumatic output pressure, which is proportional to the pressure (see graph of Fig. 3). The pneumatic signal is piped some 50 to 150 ft to the receiver gage mounted on the panelboard. The pneumatic receiver has a Ni-Span C (alloy) diaphragm spring element which converts the pneumatic signal into a dial indication of the measured pressure.

Accuracy of such readings is better than the station's required accuracy of within 0.5 per cent of full scale. Dial sizes of the receivers used are 3½, 4½, and 6 in. THE END

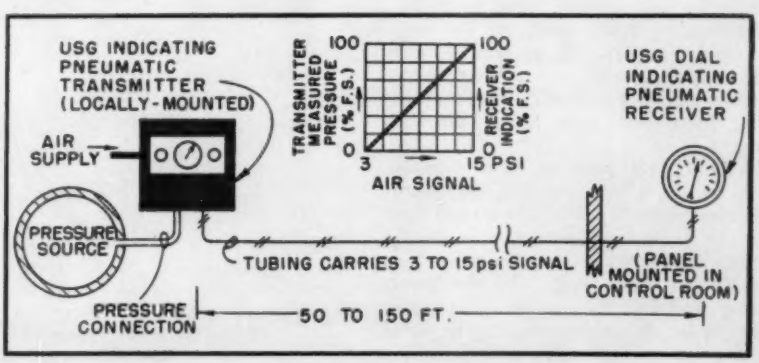


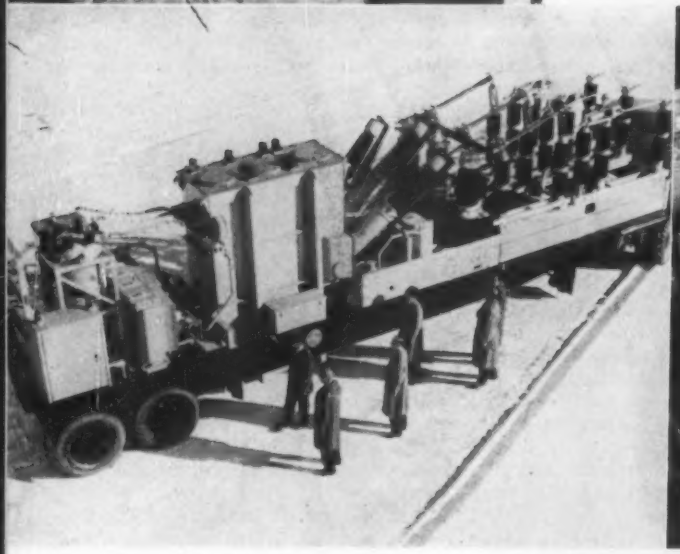
Fig. 3. Schematic of the USG pneumatic pressure transmission system. It eliminates costly high-pressure piping

1

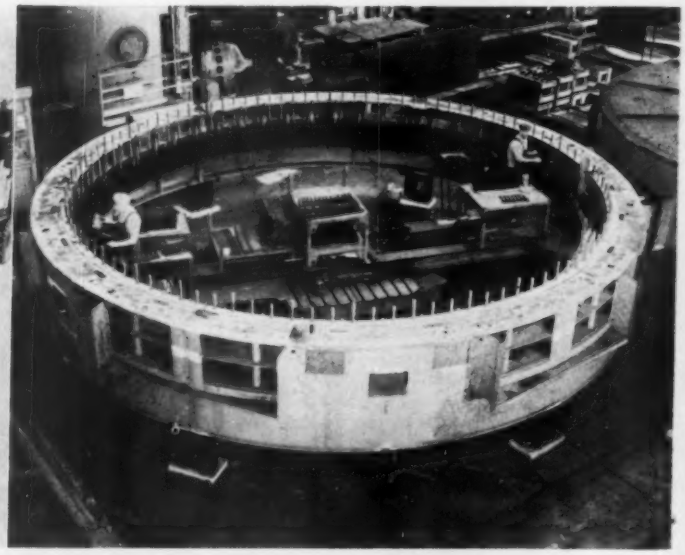
POWER ENGINEERING'S

1 5500-kw gas turbine being built by Westinghouse for the city of Austin, Minn, will be used for emergencies and peaking service at first, later will be used with a steam plant for combined-cycle operation. This will increase thermal efficiency by an estimated five per cent. The gas turbine will be installed in basement of the municipality's power plant, so that additional plant area will not be required. Its use permits Austin to defer investment in additional steam generating facilities

2



3



2 Mobile substation large enough to supply normal power requirements of a city of 25,000 is rated 17,000 kva, 115 kv. It's on its way from G-E for use by the Public Service Company of New Mexico

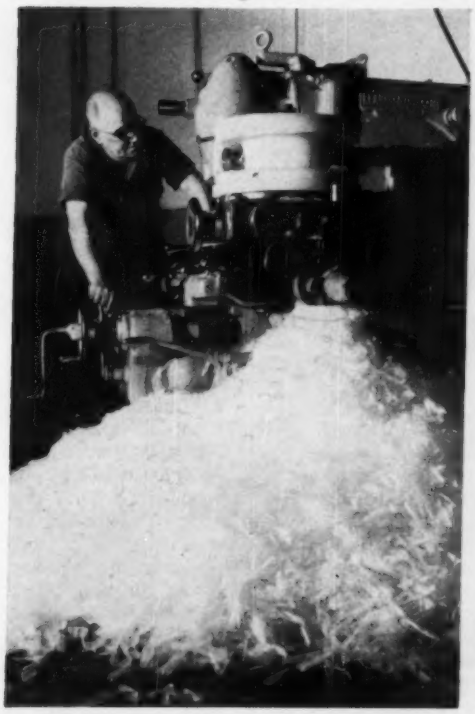
3 Motorized rotary table expedites stacking of stator punchings for large diameter motors and generators made at Allis-Chalmers. Stackers ride on the table around inside of the stator, placing laminations over stator dovetails

4

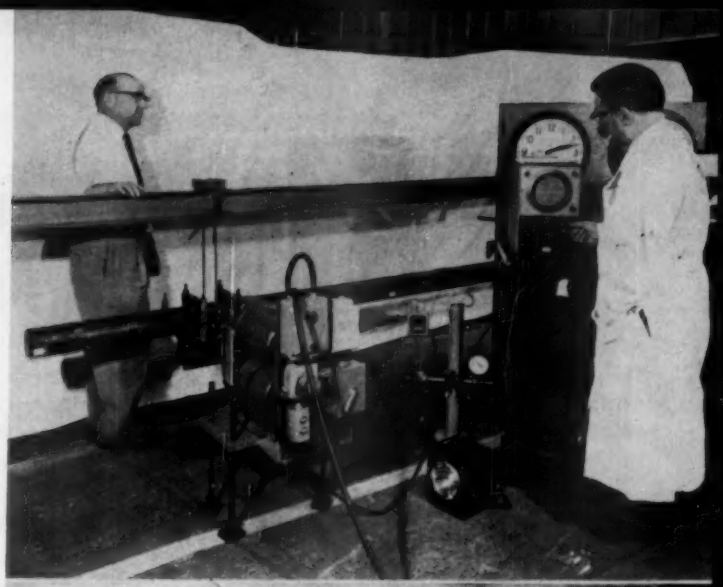
4 Clad tube sheet up to a diameter of 42 in. is now possible, Bridgeport Brass reports. Sheet shown here has diam of 36 in. Thicknesses up to 4 in. can be achieved with claddings varying from 1/64-in. to 1/2-in. Edges of the sheets are machined to tolerances of 1/16-in. to 1/32-in. depending on the diameter

NEWS REEL

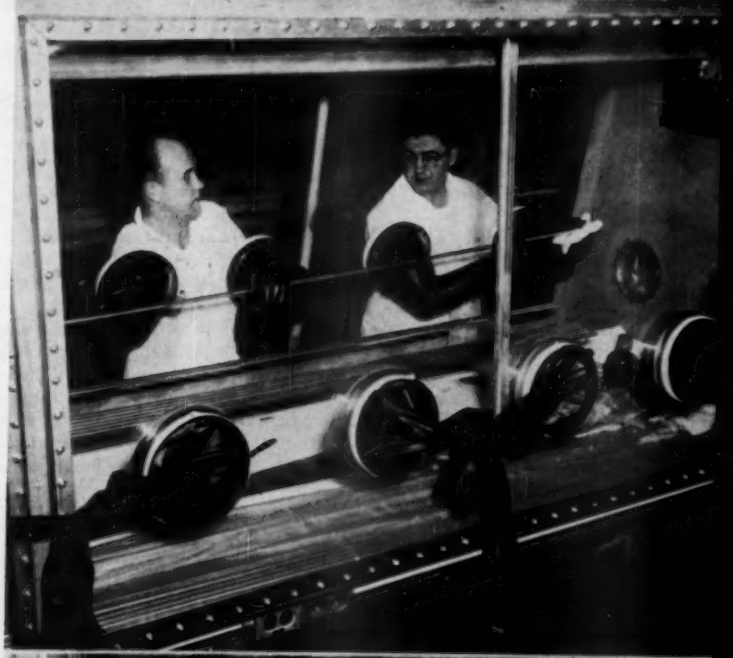
5 Polyethylene insulator, 18½ in. in diameter, being milled at Boeing Airplane Co for use with a special 2,000,000-amp electrical switch in the discharge of heavy current loads from large condenser banks. One of two, this insulator can withstand voltages approaching 100 kv



6 Years of fatigue are compressed into minutes by resonance bending tests of metal pipe and fittings at Tube Turns Div of Chemtron Corp. Vibration is induced in this 4-in. carbon steel pipe at about 4300 cycles per min. Pressure inside pipe decreases when fatigue crack occurs



7 First plutonium-aluminum alloy rods are placed in Hanford atomic plant's new plutonium fuels pilot plant. This new plant will help determine feasibility of reclaiming plutonium from uranium-fueled reactors and using it as enrichment fuel for power reactors. G-E operates Hanford



8 Cooling by water of an isolated-phase generator bus has been tested by Delta-Star. Enclosed in a 40-in. aluminum duct, the 19-in.-diam aluminum bus was of 10,000-amp capacity. Ordinary tap water was used. Test concluded that space saving is main contribution liquid-cooled bus offers

More on Steel Tanks In the Power Field

This, the second part of this series, describes the maintenance and painting of the steel tanks depicted in part one, gives facts about tank purchase and incurred costs. Information on fittings, testing procedures, and welding specifications concludes the story

By GEORGE S. TREES*

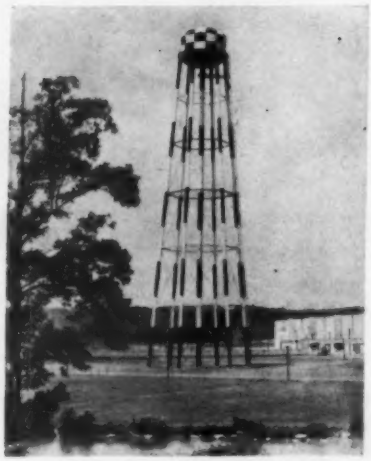


Fig. 1. This water storage tank at AEC's Oak Ridge plant is 365 ft high

PRACTICALLY every piece of tank equipment requires some maintenance; water tanks are nominally painted both inside and outside. Oil tanks are usually painted only on exposed surfaces. If a proper grade is built for a flat-bottom tank, no paint is generally needed on the underside of the bottom plates. Many times, in the case of water tanks, people look at the outside surfaces only; and, if the paint appears to be in good condition, they assume that the inside is equally so.

This is not necessarily true in many locations with very "aggressive" waters. In some cases it may be advantageous to use cathodic protection, because the proper installation and maintenance of such protection would eliminate the necessity of painting on the inside of the tank shell (and bottom) as long as the cathodic system operated. However, it would still be necessary to paint the tank above the high water line.

The condition of the paint on the exterior of a tank is self evident. Normal operating procedures call for repainting about once every five years, which may be dictated by appearance as much as by necessity. If the water stored is normal and not unusually corrosive, this five-year cycle should suffice for the interior surfaces also.

The proper type of paint to use originally on a tank is a subject of much discussion. Opinions vary widely. For many years, red lead was used very successfully on the interior of water tanks, both as a prime coat and as a finish coat. Today many people feel that lead paint should not be used on the interior of potable water tanks.

Other paints, that have been used quite successfully, are some of the phenolic paints, some of the vinyls, and also a zinc dust-zinc oxide combination. Externally, water tanks are usually painted with a prime coat which will be compatible with the finish coat to be applied. This may be a lead, aluminum, phenolic, or vinyl paint. If a light-colored paint is to be used externally, normally two coats are required in the field to cover fully the prime coat. If a dark paint is used, one coat will suffice.

The most important thing to remember about painting is proper preparation of the surfaces of the steel. If all mill scale is not removed before the prime coat is applied, it is likely that this scale will loosen, then peel and destroy the paint.

Mill scale can be removed successfully by several methods. The most complete method is pickling, where scale is removed by the use of chemicals. A good job can also be done by grit or sandblasting; however, this is subject to human efficiency, particularly when tight mill scale is involved. It is important to apply the prime coat of paint to the steel surface as soon as possible after the mill scale has been removed.

Painting can be done in the shop and in the field by brushing, rolling, or spraying. All methods are satisfactory for most paints. Certain specific paints must be sprayed, others require brushing, but these types are exceptions.

Purchasing Tanks

When sending out an inquiry to reliable fabricators, the purchaser would probably get the most attractive price simply by specifying the code under which the tank should be built, the number and approximate locations of fittings, and the capacity of the tank required.

Often a purchaser will specify a tank with dimensions which are nonstandard or which do not easily fit the stock of the fabricator. For instance, if a tank purchaser specified that the height of the tank should be 31 feet, it would probably mean that the material would have to be ordered from the mills, rather than be shipped from stock. Some fabricators carry 6-ft-width plates, some 7-ft, some 7½-ft, and some 8-ft plates.

Therefore, it would generally be more economical, unless the purchaser has unusual space requirements, to say that he would like a certain capacity tank, and give approximate dimensions. In the case of the tank specified (31 ft high) the fabricator could then use whatever width plates that are his standard, and adjust the diameter for the required capacity.

Codes of Standard Sizes

All of the regular codes (such as AWWA, API, and the Insurance) carry a stable of standard sizes. Tank fabricators, also, usually have additional standard sizes available. Normally, it is more economical for the builder to furnish a standard size because of engineering expense, templates, and standard layouts for items such as stairways and framing.

The majority of all steel tanks are erected by skilled mechanics. This means that the crew assigned to the work of erecting the tank will only do work which is classed as *boilermaker* work. Therefore, it is advantageous for the tank purchaser to handle the *general contracting items* which may be required to put the tank into operation. This would include the foundation work, piping, and electrical work. It may or may not include painting, as many tank builders have their own paint crews.

---

*Chicago Bridge and Iron Co, Pittsburgh, Penna

In the case of internal tank piping, such as heaters, inlet pipes, and shell nozzles, most labor agreements permit the tank builder to do this work so that the *subcontracted work* normally would start at a tank flange or a base elbow immediately outside the tank.

If the liquid to be stored is not a petroleum product or water, the inquiry should include the specific gravity of the material. If it is for dry storage, the purchaser should include the angle of repose and the angle of friction. The tank builder should be told whether to include a corrosion allowance, and whether there are minimum thickness requirements in the tank bottom, shell and roof.

If corrosive liquids are to be stored (and special metals are required), the fabricator should be instructed as to the type of material on which to quote. If the tank is to be lined, specific instructions as to the grinding of the welds and rough spots should be mentioned in the inquiry so that bidders will be quoting on the same basis. Many purchasers have specific preferences as to roof design and other details. These items should be clearly stated in the inquiry.

Purchasers frequently ask as to the most economical size tank to specify for a given capacity. This is difficult to answer without knowing the product to be stored, the location, the soil-bearing characteristics, and many other variables. In the case of flat-bottom oil or water-storage tanks, the most economical height appears to be somewhere between 32 and 48 ft. Space limitations can affect the optimum size, as it may be more economical to build a high (and more expensive) tank if land is unavailable or at a premium, or if pile foundations must be built.

Table I. Approximate dollar prices of welded double ellipsoidal elevated tanks

Capacity (Gallons)	Diameter of Tank (Feet)	Head Range (Feet)	Price of Tank—Elevated 75 ft to Bottom	Price of Tank—Elevated 100 ft to Bottom	Average Foundation Prices for Both Heights
50,000	22′	19′	$25,000	$26,000	$2500
75,000	26′	21′	30,000	33,000	2800
100,000	28′	24′	32,500	35,000	3500
150,000	32′	27′6″	43,000	48,000	4500
200,000	36′	29′6″	50,000	56,000	6000
250,000	40′	29′	59,000	65,000	7500
300,000	43′	30′	63,000	70,000	9000
400,000	46′	35′	80,000	88,000	11,000
500,000	50′	37′6″	95,000	105,000	13,000
500,000	56′	30′	105,000	115,000	14,000

Note: Diameters and head range will vary with different fabricators. Watersphere prices will average 15 to 20% more than comparable ellipsoidal tanks. Tank prices include material, fabrication, freight, erection, standard accessories, pickling, and painting. Foundations are based on 4000# per sq ft soil bearing.

Tank Fittings

Certain tank fittings are automatically included with a tank quotation. In the case of tanks for elevated water storage, the fabricator normally would include an inlet pipe, terminating in a base elbow in the valve pit. This pipe serves as both inlet and outlet. For plant use, the tank will normally "ride on the line." If used for fire protection service only, the inlet pipe would be connected directly to the sprinkler system.

If a tank is to be used for dual service (general and fire protection), insurance companies frequently require an additional pipe up to approximately the center of the tank. The upper portion of water would then be used for general service, and the lower section would be reserved for fire protection. Other standard fittings include outside tank and tower ladders, manhole in riser pipe, roof hatch and roof vent.

A balcony is usually furnished with

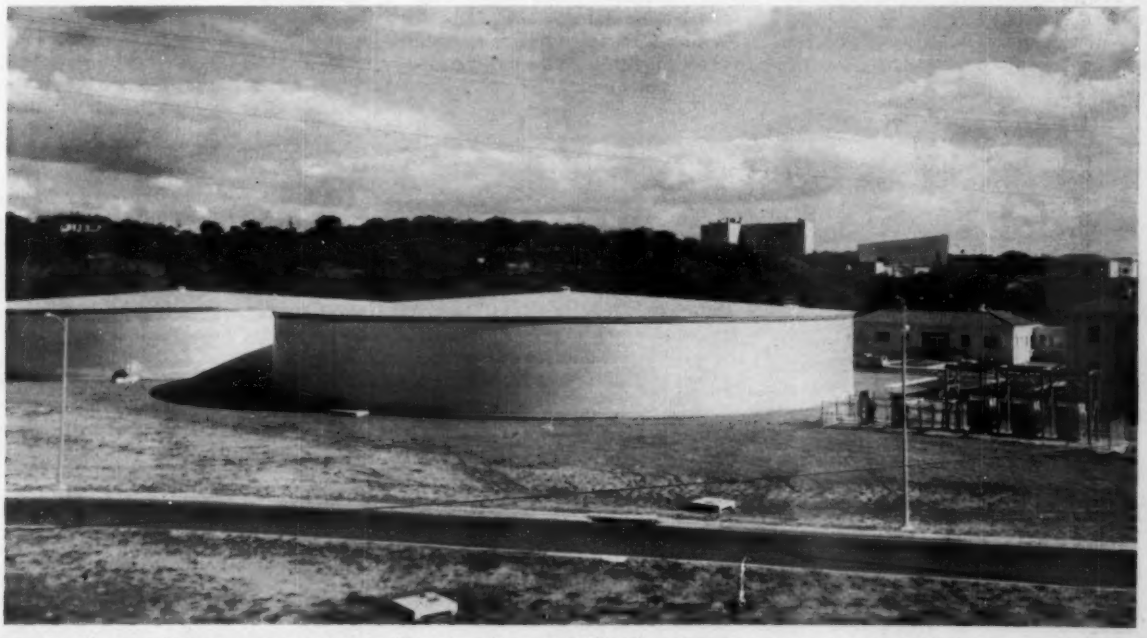


Fig. 2. Plenty of storage space is provided by these 6,000,000-gallon-capacity tanks. Note their cone roof design

the double ellipsoidal, but not with the spheroidal or tripod type. Safety cages on outside tank ladders are optional but are sometimes required by ordinance. Most insurance specifications require *inside* tank and riser ladders plus heating equipment previously described.

On flat-bottom water storage tanks, the inlet-outlet pipe can be either welded to the bottom and terminate in a base elbow or can be a flanged shell nozzle.

On flat-bottom oil storage tanks, standard fittings include an outside tank ladder or spiral stairway, a shell and roof manhole, flanged nozzles, or nipples in the roof (for venting) and in the lower ring of the shell (for inlet-outlet and water drawoff purposes). Special fittings are required if the oil tank is to be heated. Inside tank ladders are not normally included in oil tanks because of safety reasons.

Thermowells and thermometers, automatic tank gages, gage boards, pressure vacuum vents, and overflows are among some of the other fittings in common usage.

Welding Specifications

Standard specifications, such as AWWA and API, have definite requirements for welding and welding examination. Welders should be qualified, and the tank builder should be required to produce proof of the welders' fitness. In water tanks, both the horizontal and vertical joints are usually 100 per cent welded.

API Specifications do not require a 100 per cent joint (or full fusion) in the circumferential welds over $\frac{3}{8}$-in. thickness, but do require 100 per cent joints on all vertical welds. Small tanks are nearly always manually welded. If a large tank job is involved, or the single tank is 100 feet in diameter or larger, tank builders frequently use automatic girth seam-welders.

Elevated water tanks are practically all butt-welded, although part of the roof above the high water line may be lap-welded. Flat-bottom tanks have lap-welded bottoms, and roofs which are welded from the top side only.

All welds should be cleaned of slag and examined visually. The various codes also provide for examination of the welds by sectioning or spot X-ray. When heavy oil or water tanks are involved, certain customers specify complete X-ray of the heavy vertical tank seams.

While X-ray can give a clear picture of the welding and has the great advantage of being a non-destructive test, normally it is not economical to set up an X-ray machine and dark room on small tank jobs.

Elevated water tanks are subjected to a water test and are visually inspected. The bottom plates of flat-bottom tanks normally are tested with soap suds and a vacuum box. The tank shell itself is subjected to a complete water test and visual inspection. On some occasions, cone roofs are vacuum-tested also. In the case of an oil tank, it is always important to provide water for the complete test of the tank. If a leak is not discovered until the tank is filled with product, expensive cleaning and gas-freeing may be required before the leak can be repaired.

Table II. Approximate erected prices of API cone roof oil storage tanks

Capacity in Barrels	Diameter	Height	Tank Price	Extra for Shop Pickle and Paint Plus Field Paint
5000	30′	40′	$9000	$1200
10,000	42′6″	40′	17,000	1700
15,000	52′	40′	23,000	2100
20,000	60′	40′	28,000	2500
25,000	67′	40′	34,000	2800
30,000	67′	48′	39,000	3200
40,000	85′	40′	49,000	3700
55,000	100′	40′	63,000	4700
80,000	120′	40′	85,000	6100
100,000	134′	40′	102,000	7200
120,000	134′	48′	121,000	8000
150,000	150′	48′	150,000	9000
180,000	180′	40′	180,000	11,000

Note: Diameter and heights will vary with different fabricators. Prices include standard accessories but no special fittings. No foundations are included in these prices because of wide variance in methods and prices.

Tank Costs

It is difficult to assemble exact costs or estimating figures for field-erected storage tanks. Labor rates and local union rules vary throughout the country. Also, freight rates can affect the price considerably.

However, tabulations of common sizes and approximate costs are shown in Tables I and II, for both elevated and ground-level storage tanks. It must be remembered that these figures will not fit all locations, but they are general.

Tank fittings are an important part of the total tank cost. For example, $15,000 tanks have been built with no fittings other than standard. The same tanks, with many special fittings, could run as much as $5000 more. From this it is obvious that percentagewise, tank fittings and painting can seriously affect the total tank cost, and this is most apparent in the smaller tanks. The cost of tank foundations vary with the location, the soil characteristics, and also the terrain. THE END

Fig. 3. Foundations are laid for cone roof tanks of 150,000-barrel capacity

Plaideau

This 400-ton community incinerator was built in New Orleans in the mid-1950's

After the combustion process, what happens in an engineered incinerator? In this continued discussion of modern waste incineration practice, the author takes up operating problems of . . . .

Incinerator Stacks and Ash Disposal

By JOHN H. D. BLANKE*

AN INADEQUATELY constructed or a poorly operated community incinerator tends to deliver excessive quantities of smoke, dust or fly ash, and obnoxious gases to the atmosphere. The tendency is aggravated by promiscuous burning of rubber and other materials of high combustibility. Excessive smoke may be curtailed by blending of waste in the pit before charging the furnace. Discharge of excessive quantities of diverse irritating gases is due chiefly to incomplete combustion.

Under ideal conditions, only sulphur dioxide, carbon dioxide, and water are passed up the incinerator stack. Many communities limit the emission of dust from stacks by legal restrictions to a maximum of 0.85 lb per 1000 lb of flue gas or to 0.4 grains per cu ft, both corrected to 50 per cent excess air. One large eastern city is effecting a fly ash reduction to about 0.6 lb by use of water spray gas scrubbers.

Dust or fly ash produced in the combustion chamber of an incinerator may be removed from the flue gases by gravitational, inertial, electrostatic, magnetic or mechanical devices. In checking a score of incinerators recently, nearly one-half of the plants were found to be using wet sprays for fly ash precipitation; of the other plants, some used baffles, or a large flue, a multi-vane, or rotary filter.

Recommended practice is to cool the flue gases by evaporating sprayed water into steam, thereby increasing the flue gas volume and relatively diluting fly ash and gas content. The process is performed conveniently in a settling chamber or enlarged flue following the combustion chamber. However, the expansion chamber cannot settle out effectively all fly ash and dust that should be removed under today's standards against air pollution — and dilution to the atmosphere is seldom the practical method.

Most incinerators are equipped with expansion chambers or enlarged sections of the flue gas passages to allow some of the ash and dust to settle out. Some plants have water sprays in the expansion chamber to promote depositing of fly ash. Other plants use multiple cyclone fly ash arresters, which are handicapped, however, by the high gas temperature.

Installation of a waste heat boiler in place of or in conjunction with the expansion chamber helps to cool the gases, reduces their volume, slows their velocity and results in greater fly ash deposit.

In four incinerator plants reporting recently, the volumes of the expansion chambers ranged from 8.5 to 15 cu ft per ton of rated capacity, with an average of 11.6 cu ft.

Height of Chimney

It has been customary to build incinerator chimneys of 7 to 13 ft inside diameter and to heights ranging from 125 to 250 ft, depending on plant equipment and topographic conditions. The new trend is to build short chimneys and provide adequate flue gas filtering equipment plus draft fans.

To cite one example, the new 200-ton incinerator at East Hartford, Conn, located adjacent to an airport, was restricted in stack height to only 100 ft. To solve a potential fly ash nuisance problem, a large expansion chamber was built into the incinerator for slowing the velocity of flue gases and thus permit large particles of solids to drop from the gas stream.

A refractory brick baffle wall with perforations 2½ in. square was placed across the middle of the expansion chamber. Area of the perforations was balanced after placing the incinerator in service so that just sufficient draft could be maintained in the firebox of the stoker to maintain safe operation. The perforated baffle wall which extends the full height of the expansion chamber stops a major quantity of the fly ash from reaching the stack..

A dry type of dust collector is quite often installed to remove fly ash from incinerator flue gases. Generally the unit is of a multi-cyclone design. The gases must be cooled to about 700 F before entering the collector. The temperating is done by injecting cold air, by introducing sprays of water with fog-type nozzles, or by both means combined.

Sufficient heat is left in the cleaned flue gases to superheat the moisture introduced in the cooling method, and to aid in producing sufficient stack draft. The resistance produced in passing the flue gas through the dust collector is overcome with an ID fan, and the fan aids in passing the gas through the collector at required velocity. The cyclones are effective for dusts above 10 microns in size. For removal of dust less than 10 microns in size, electrostatic precipitators are used.

Cyclones installed at the Hempstead, N. Y., 700-ton incinerator entrap 90 per cent of the dust particles down to 15 micron size. Flue gases are discharged through two 175-ft stacks by aid of ID fans. An electric alarm is sounded should the cyclone collectors fail to produce a clean exhaust. At the Alexandria, Va, 200-ton incinerator, an alarm is

*Technical writer. Member of Western Society of Engineers. Earlier articles in Mr. Blanke's series have appeared in POWER ENGINEERING of September, 1959, p. 96; November, 1959, p. 69; and February, 1960, p. 82.

sounded whenever the density of gases going up the stack exceeds a predetermined maximum.

At Oyster Bay, N. Y., the fly ash from incinerator flue gases is recovered by means of a water-filled trough-like bottom installed in the expansion chamber. A deflecting damper forces the gases against the water, trapping the fly ash. Spraying the dampers with water helps precipitation. Low-pressure steam is also introduced at the chamber inlet. Only about 0.30 lb of solids pass up the stack per 1000 lb of gas.

Ash Disposal

Ashes discharged from incinerator furnaces are handled in various ways to final disposal. In most engineered installations they are quenched by discharge to a water-filled receiver before conveyance to storage tank or truck. The ashes not only lose heat for easier and safer handling but are handled dustlessly when quenched. Fly ash collected from expansion chambers and flues may be added to ashes in final disposal.

At Hempstead, N. Y., the furnace residue, after quenching, is delivered by screw conveyor to a bar screen which deflects tin cans and other bulky materials into a hopper, allowing screened ashes to drop into a receptacle below.

In the Oyster Bay, N. Y., incinerator, the ashes drop from the furnace through a pair of balanced ash gates to an hydraulic sluiceway for quenching, and water carries the ashes along to a tank outdoors. Periodically a crane with clamshell bucket loads the stored ashes to trucks. The sluiceway is lined with vitrified brick and supplied constantly at the inlet with a stream of water. In addition, nozzles spaced along the sluiceway eject water under high pressure to force the ashes and other residues to the tank.

At the Louisville, Ky, incinerator the inert residue passing from the rotary kiln is quenched in a water trough, then delivered to a revolving screen, where the residue is washed with sprays of water to remove particles of ash. The washed material, consisting of cans and other metal objects, is then passed to a baler for disposal to the scrap metal trade.

To avoid possible re-entrainment in the flue gas stream, fly ash should be removed from the settling chamber continually, immediately on deposit, and discharged to ash disposal. Removal may be effected by water or vacuum.

The waste spray water and fly ash leaving the Miami incinerator furnace is flushed to a refractory trough which terminates in a settling tank. Fly ash collected in water at the Oyster Bay, N. Y., incinerator is settled out in a 50-foot-diameter tank by aid of an ash-water clarifier in a one-hour settling period. The sludge is discharged to a lagoon, but the clarified water is reused.

At a recently-built incinerator in St. Louis the dry fly ash is picked up at various points on the bottom of the expansion chamber, and breeching occurs by means of a flexible hose connected to an hydraulic vacuum system.

Obviously, operations in the incinerator plant require water. Supply sources range from deep wells through city mains to effluent from sewage treatment works.

Ash quenching at the Alexandria, Va, incinerator is also done with effluent from an adjacent sewage treatment plant, this being easier and cheaper to obtain than deep well water.

Water used in quenching ash is reused in some plants after temporary storage in a settling tank, as for instance at Oyster Bay, N. Y. The Hempstead, N. Y., incinerator is supplied with cooling water for its waste heat boilers through a 36-in. intake line from a nearby river, by use of four 3000-gpm centrifugal pumps installed in a pump house behind a traveling screen. THE END

Want reprints of Mr. Blanke's series of 4 articles on the various phases of solid waste incineration practice? Write The Editor, POWER ENGINEERING. This series covers power aspects of burning waste, design and operation of the big incinerator furnaces, trends in stokers, incinerator stacks and ash disposal

New Test Quickly Predicts Metal Cracking

NOW THERE IS a simple, inexpensive and much faster test, devised by a Westinghouse research scientist, for predicting hot cracking in stainless steels and other alloys.

Hot cracking occurs when metal alloys crack under the heat and stress of welding, or tear when freezing out from the molten state as a casting.

Testing is based on the fact that the tearing of a metal casting as it cools and shrinks from a liquid into a solid is comparable to the cracking of a weld as it freezes.

Thus, study of small metal castings for hot cracking susceptibility is equivalent to study of welds in very large samples of the metal.

Small castings required are prepared by melting a 20-gram sample 10 to 15 sec in a protective atmosphere of argon.

The sample floats inside a coil carrying high-frequency electric current; magnetic field around the coil supports the sample in space, heating it white hot and causing vigorous stirring action.

After the sample melts, coil current is decreased, and molten metal pours through an opening in the coil into a copper mold of special design. Metal then freezes into the shape of a slightly tapered pin averaging two in. in length and one-fourth in. in diameter.

Top and bottom of the pin lock in place to prevent normal contraction of the metal, thus setting up tensile stresses in the pin as it cools and shrinks inside the mold. The longer and slimmer the pin, the greater the tearing.

A numerical scale is built up to describe the susceptibility to hot cracking, by comparing pins of different lengths and diameters.

This scale is thus used to evaluate this characteristic in alloys of different compositions.

Dr. F. C. Hull, developer of this method, calls it the "cast pin tear test." The test, he feels, makes "laboratory measurements feasible."

He revealed that the test was applied in more than 3700 individual testings of various alloys, particularly stainless steels.

"Changing the alloying constituents of stainless steel affects its resistance to hot cracking," Dr. Hull said. "Yet such changes in composition constantly must be made during the development of an alloy having high strength, good corrosion resistance, and other desirable properties."

What to Expect of Motor Bearings

By R. L. NAILEN*

Many electric motor troubles involve the bearings. To forestall operating problems, when specifying and using motors, you should know the bearing types described here, where they are used, and their life expectancy. Future articles cover lubrication and how to select right bearings for each job

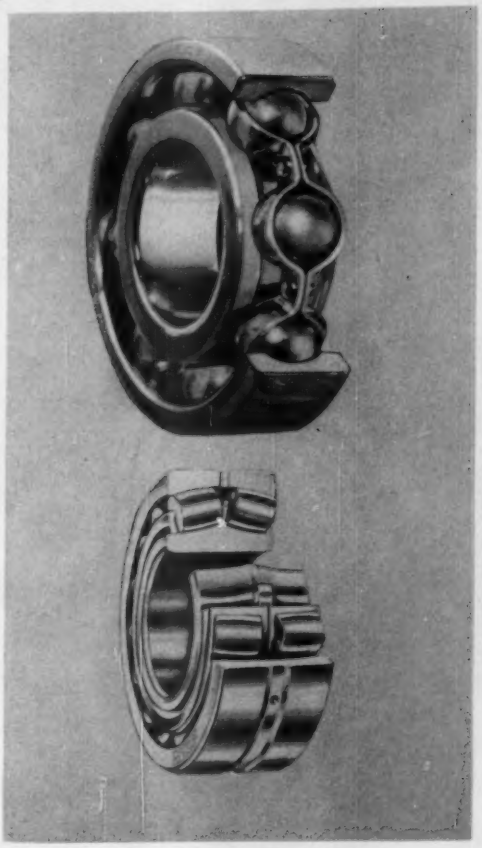


Fig. 1a (top). An "upper" single row deep groove ball bearing. Fig. 1b. Spherical roller bearing

WHEN APPLYING electric motors, many power engineers have an understandable tendency to think of them primarily as electrical machines. But a motor has major moving parts; consequently it is subject also to the strictly mechanical problems of all rotating machinery. Most of these problems involve the bearings. The following discussion of motor bearings and lubrication should help users forestall some application problems.

Standard horizontal integral horsepower motors, in the NEMA frame sizes (up through 125 hp at 1800 rpm), are furnished with ball bearings. Except for some of the smallest sizes, sleeve bearings may be obtained as an optional alternate — however, off-the-shelf delivery is not to be expected. The medium-size machines (150 to 600 hp at 1800 rpm) may readily be obtained with either ball or sleeve bearings. Still larger motors are normally supplied with sleeve bearings; ball (or roller) bearings are optional, and are used principally in applications requiring high bearing loading due to belt pull or end thrust.

Many types of ball bearings have been used. Most common is the Conrad-type S "deep-groove" radial bearings, Figure 1a, with either a single or double row of balls. This bearing, because of the depth of ball groove, has a considerable thrust capacity — 60 to 80 per cent of the radial load capacity. A further advantage of this construction is its adaptability to various combinations of shields and seals used to retain lubricant and exclude dirt from the bearing.

When bearing loading, either radial or thrust, exceeds the capacity of this type of bearing, a roller bearing or double row ball bearing may be supplied instead. Spherical roller bearings, Fig. 1b, are inherently self-aligning, therefore best for high belt loads that cause small deflection of the motor shaft. They are not suitable for operation at 3600 rpm (which is too high a speed for belted motors above 25 hp anyway; nor are they suitable for 1800 rpm in the larger bearing sizes).

Vertical motors universally employ ball or spherical thrust roller bearings, except in the large sizes with very high thrust loading and/or high speeds, and here the Kingsbury thrust bearing, Fig. 2, is used. (This bearing is not usually available on motors in the "medium" sizes.) Though complex in construction, the Kingsbury bearing is a sliding bearing — in essence, a flat sleeve bearing rather than a cylindrical one.

Vertical motor ball bearing arrangements vary with the nature of the load, but small and medium size motors use the angular contact thrust bearing as standard. In this bearing, the outer race has a high shoulder on one side of the raceway and a low shoulder on the other. The normal line of contact between balls and races forms a large "contact" angle with the race centerline, Fig. 4a. This enables the bearing to carry large axial thrusts. When the load exceeds the capacity of a single bearing, the bearings may be stacked two, three, or four high, Fig. 4b. Thrust capacity of the stack will increase as $N^{0.7}$, where N is the number of bearings in the stack.

Customarily the thrust bearing is

*Motor Engineering Section, Manufacturing Div, Westinghouse Electric Corp

located at the upper end of a vertical motor. To hold the rotor-shaft assembly centered in the stator, a lower guide bearing is provided. When all the thrust load is downward, thrust is taken entirely by the upper bearing, and the guide bearing is virtually unloaded. However, many pump motors are subject to upward as well as downward thrusts due to pump operation. One common way of handling this is to lock the lower bearing to the shaft and let it take the upthrust. The reason this is feasible, even though the guide bearing is only a radial type with lower thrust rating, is that upthrust is seldom more than 30 per cent of the downward value, and is usually present only momentarily, rather than continuously.

Use of the extra parts necessary to lock the guide bearing is avoided by another method of carrying upthrust. This is the "split inner race" angular contact thrust bearing, Fig. 4c, which is standard with some motor manufacturers. Inner and outer races have high shoulders on either side of the ball raceway, which give the high contact angle, and thrust capacity, in both directions.

To assemble the bearing, the inner race is split in the center. This type of bearing may be operated singly, or stacked with the standard angular contact type. However, use of two or more split inner race bearings in a stack, to provide high thrust capacity in both directions, presents lubrication problems and is not recommended.

A word of caution: in ordering vertical motors for pump applications, be sure to advise the manufacturer if the pump thrust is expected to be "balanced" or nearly so for more than a few seconds at a time. This condition occurs in applications such as booster pumps in power station condensate systems, where the pump and motor may run for long periods at light loads. The result is that the motor may "float," being subjected to neither upthrust or downthrust. If the motor thrust bearing is of the split inner race type, such operation damages the bearing and leads to early failure.

Little needs to be said about the sleeve (sliding) bearing. As used in motors, it is a babbitt-lined steel cylinder, lubricated by oil picked up from a sump by an oil ring which rides on, and rotates with, the shaft. The babbitt is usually a lead or tin base alloy. Aluminum base babbitts have been used under unusually corrosive conditions; however, in modern motors with reasonable maintenance, this is seldom a problem.

Early sleeve bearing designs were two to three times greater in length than in diameter. Present practice is a length-to-diameter ratio of from 1:1 to 1.5:1. This reduces the bad effect on the bearing of slight shaft deflections. Figure 3 shows a typical split sleeve bearing as used in large motors.

Bearing Load Ratings

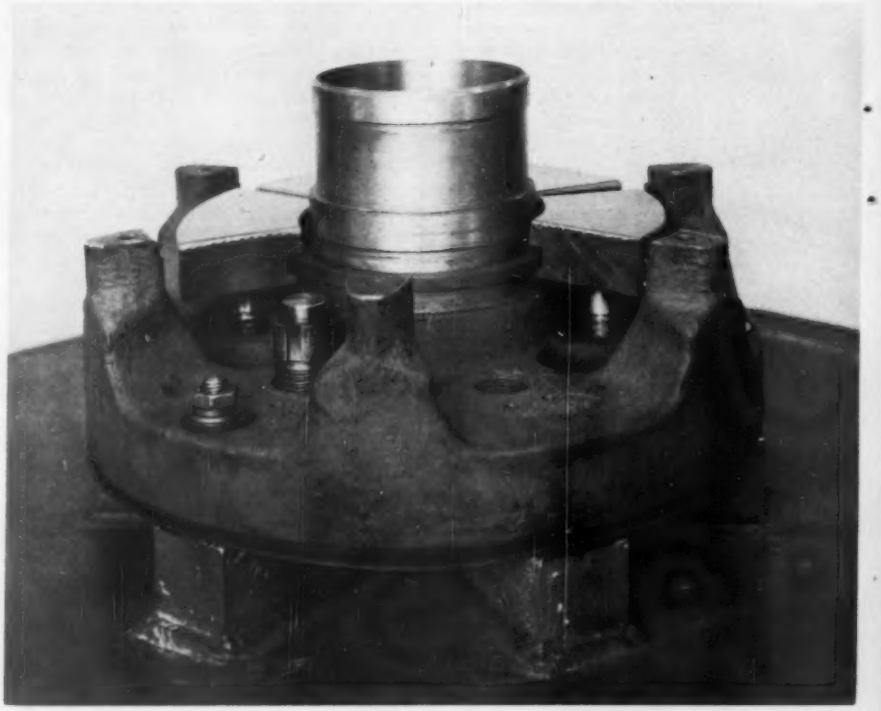
How are these bearings rated in terms of load carrying capacity? For sleeve bearings, the answer is simple. Though provided with a "thrust face" at one or both ends for the rotor-shaft assembly to bump against momentarily, the sleeve bearing has very little thrust capacity. Some large sleeve bearings are available with special oversize thrust faces to carry end thrust up to about 500 lb. These are used principally on motors driving Jordan beaters in paper mills, and must be specially ordered.

Radial load up to 150 psi of projected bearing surface may be carried by motor sleeve bearings. Based on this, a bearing 3 in. in diameter by 4 in. long should be able to carry a load of $3 \times 4 \times 150$ or 1800 lb. However, two factors operate to reduce this capacity. In the first place, the entire surface of the bearing is not available for carrying load. Portions of the surface area are cut away to provide the oil grooves and pockets that maintain the oil film necessary for lubrication.

Secondly, the location of some of these pockets or "reliefs" is such that the load carrying capacity is not the same for various directions of radial load. This is a major reason for specifying the direction of belt pull when ordering large sleeve bearing motors for belted service.

These limitations usually result in a more conservative figure of 60 to 100 psi of allowable radial load for motor sleeve bearings. While far below the 1000 or more psi allowable for sleeve bearings in some other types of machinery, this figure reflects the longer life expected of motor bearings, subject to slight shaft misalignment and relatively loose fits, compared to conditions in an automotive engine, for example.

Fig. 2 shows a partial assembly of large Kingsbury-type thrust bearing for a vertical high-thrust motor with several of the individual thrust shoes in position



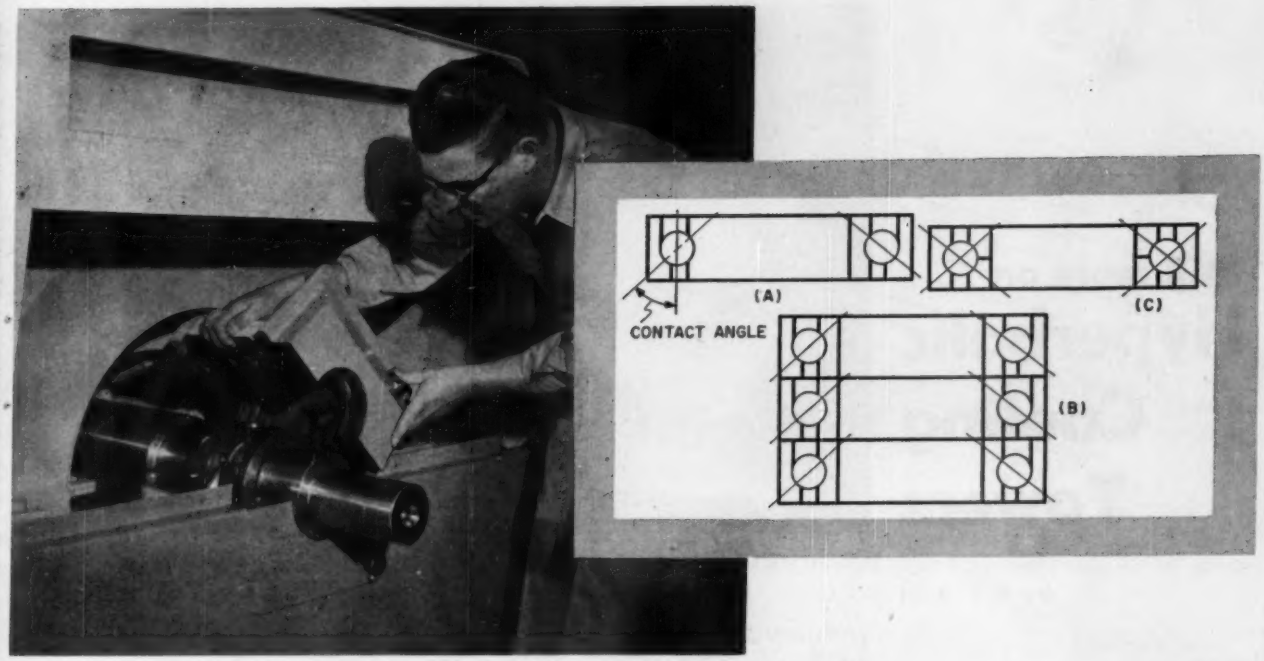


Fig. 3 (left). Split sleeve bearing as used in large induction motors. Note the ease of removal of bearing halves, without disturbing the bearing bracket. Fig. 4. (A) Angular contact thrust bearing. (B) Stacked (triplex) angular contact bearing for a very high thrust. (C) Split inner race bearing for a bi-directional thrust. The thin lines in each of the drawings point out the direction of thrust

Given reasonable lubrication and protection from bearing currents. sleeve bearings will last almost indefinitely at loads within the foregoing limits.

Load rating of antifriction bearings (ball and roller) is much more complicated. Since the bearing operation depends upon a rolling contact between ball or roller and raceways, which results in continual alternating stress in these parts, the eventual result will be fatigue failure of either ball or raceway, regardless of lubrication, or lack of it.

Predicting Bearing Life

Life of the bearing is the length of operating time that will pass before such failure begins to occur. For bearings of a particular manufacture, it is possible to predict this life, but only on an average basis for a large number of similar bearings.

It is predicted in two ways: 1, the "minimum life" for a bearing that is one of a group of bearings is the time that 90 per cent of the group will operate before the first evidence of fatigue develops; and 2, the "average" life of the bearing is the average of the life-before-failure for each bearing in the group, and is five times the minimum life as determined by standard test methods.

Both these life figures will vary predictably with the bearing load and with the type of load, whether radial or thrust. For a given type of load on a ball bearing, for example, the relation between life and load is:

$$\frac{\text{Life at load } F_1}{\text{Life at load } F_2} = \frac{(F_2)^3}{(F_1)}$$

Motors that are not ordered for any specified conditions of bearing load are not considered to have any stated bearing life. Shaft rigidity usually dictates bearing sizes large enough to insure bearing life of many years. However, when specific thrust or radial load conditions are present in the application, it is important to understand what bearing life the motor manufacturer will work to, in selecting the bearing. The bearing will normally be chosen to give either one or two years' minimum life, the large motors, particularly for power house auxiliary service, getting the longer life. This, of course, means an average life of 5 to 10 years' continuous operation at the specified loading. If the motor is run only 12 hours a day, the result is an average service life of 10 to 20 years.

Some motor specifications are written calling for a minimum bearing life of over 100,000 hours (12 years or more). When this is applied to vertical motors with high downthrust, particularly at 1800 rpm, the angular contact ball bearing combination will usually have to be rejected in favor of a water-cooled spherical roller bearing with an attendant increase in first cost and maintenance. When such a specification is written, it should be kept in mind that such a minimum bearing life exceeds the life expectancy of the average stator winding. It may therefore be not only costly, but unnecessary from a motor reliability standpoint, to insist on extremely long bearing life. THE END

MORE TO COME...

Still more on . . . Hyperbolic Cooling Towers

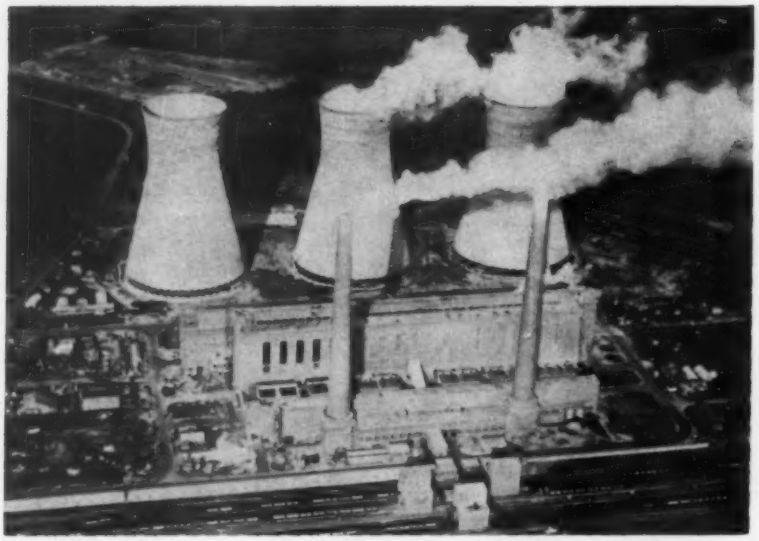


Fig. 1. Typical steam electric generating plant using hyperbolic cooling towers

By B. F. RISH

Central Electricity Generating Board, London

Location of steam plants at the coal mines, rather than on a river, offers greater possibilities for use of cooling towers. Here, the author states a case for hyperbolic towers, and gives some cost data—both for original installation and maintenance

COOLING TOWERS are devices for throwing away large quantities of low-grade energy, and it is logical to make this energy work for itself rather than use electric power in fan drives. In a hyperbolic tower, this is achieved by the construction of a large chimney above the "cooling pack."

The hot, moist air leaving the pack is lighter than the air outside, and a draft is created, which depends on the height of the tower and the difference of density. The chimney, or shell (which is normally built of reinforced concrete), is relatively cheap in the larger sizes, and cooling towers have been built in *single units* for generating sets up to 200 megawatts. Comparative costs of hyperbolic and mechanical-draft cooling towers under British conditions are indicated in the following example.

A cooling tower for a 120-Mw unit requires a water circulation of 36,000,000 lb per hr, with a cooling range of 17 F. The approach to a wet-bulb temperature of 62.8 F and a relative humidity of 60 per cent is 15.8 F, giving a recooled temperature of 78.6 F. This requires a hyperbolic cooling tower about 330 ft high and 220 ft base diameter, costing approximately $462,000 complete, with pond and foundations.

A mechanical-draft tower for the same duty could consist of 13 cells, each 32 ft square, at about the same capital cost (for an all-timber tower), and about $70,000 more with a reinforced-concrete casing. Also, the differential power costs amount to about $112,000 for the mechanical-draft cooling tower.

It is obvious that on this basis there is no case for mechanical-draft towers. Actually this comparison is rather unfair, as the cooling-duty chosen has been optimized for the hyperbolic tower. The case for the mechanical-draft tower is not quite so bad, if the *optimum conditions* for it are chosen, as well. (The selection of the most economic duty for

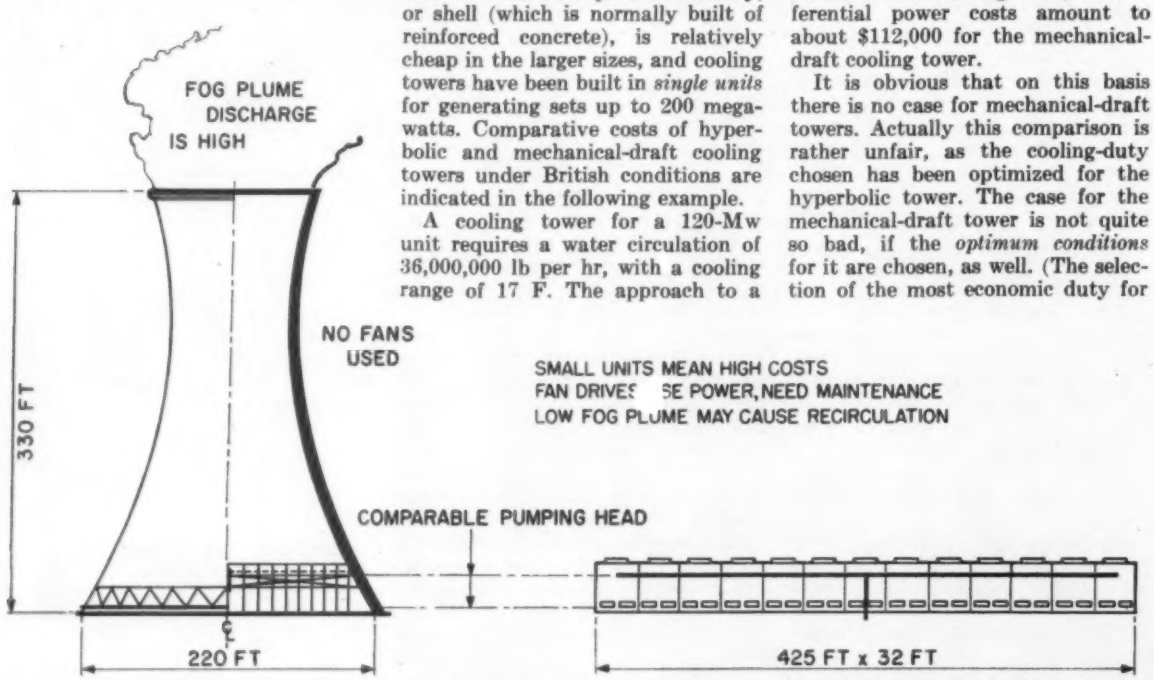


Fig. 2. Comparison of conventional and hyperbolic cooling towers for 120-Mw turbine-generator unit. Note relative heights

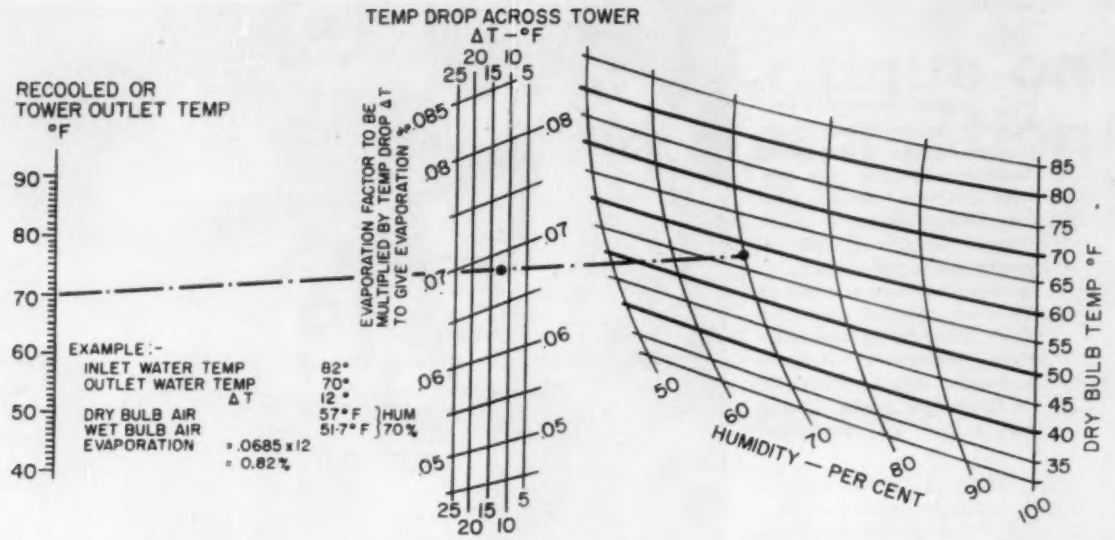


Fig. 3. Nomograph for calculating evaporation of cooling tower water. Example gives evaporation loss of 0.82 per cent

cooling towers has been dealt with by the author in ASCE paper No. 2227, recently published.)

Apart from the first cost, and operating cost, of the two types of cooling towers, there are other advantages in favor of the hyperbolic tower. The vapor plume is released at a great height, and there is no danger of the recirculation of moist air or the production of ground fog. This can be shown by the fact that air temperatures are the same, *up-wind* and *down-wind* of the tower.

There is no switchgear to maintain, gears to oil, fans to get out of balance — and no case noise and vibration. The air velocity through the packing is generally below 5 fps, and with the efficient drift-eliminators now available, carry-over of water droplets can be reduced to a level that is difficult to detect. This obviates any danger due to icing of roads in frosty weather, or flash-over on high-tension electrical equipment — due to the contamination of the insulators with salts from the water.

The following maintenance is generally required for hyperbolic towers:

1. Any silt in the make-up water will accumulate in the ponds, and these may have to be cleaned about once a year. This is usually done by washing down (with high-pressure hoses) to a sump, from which the silt is pumped to outside disposal.

2. The nozzles of the pipe distribution system (above the pack) may get partly clogged with sediment during the first week's operation. After that, once a year is usually sufficient for clearing out leaves and other debris which may escape the screens of the make-up water.

In Britain, it is customary to employ a plentiful supply of make-up water, generally about three per cent of the circulating quantity. This means that the only treatment required is intermittent chlorine dosages, to prevent algae growth on the tower-packing and slime growth on the condenser tubes. In France, however, there are areas where even make-up water is scarce, and purges of only one-tenth of the evaporation loss have been successfully used.

In this case, as all the salts in the water concentrate by a factor of ten, extensive treatment is required to prevent scaling and other troubles. Figure 3 is a nomograph which gives evaporation losses in hyperbolic towers, calculated for a range of cooling duties and ambient temperatures.

Maintenance Costs

Maintenance costs are thus negligible on a hyperbolic tower, at least in the first twelve years of its life. This may be compared with a recent American survey (POWER ENGINEERING, Feb, 1957, page 79) which indicated that, of 50 post-war mechanical-draft cooling installations, the average maintenance cost was over four per cent, annually, of the first-cost of the towers.

After twelve to fifteen years of life, timbers in the pack have usually decayed to the state where they had to be replaced. Better methods of timber treatment are being developed, which will extend the life of the pack; also, more permanent materials (such as corrugated asbestos-cement) have been tried out and are very promising.

It is advisable, when installing hyperbolic cooling towers, to arrange the piping so that *all* the towers can be used, even when some of the turbines are shut down. If half of them are used on all the towers, for instance, then in the conditions of the previous example there will be a slight savings in pumping power, due to smaller friction losses in the piping; and the recooled temperature will be about 6 F lower.

Hyperbolic towers have been built in large numbers during the last 30 years, and a great deal of know-how has been accumulated on the design and construction of the concrete shells. It is not considered likely that anything more economical than *cast-in-place concrete* will be developed. A few hyperbolic towers have been built with pre-cast concrete, but these have turned out to be costlier than the conventional type.

It has been suggested that aluminum could be employed, and this deserves careful consideration. Care would have to be taken, however, with the other metals employed in the circulating-water system, to avoid electro-chemical attack. For example, copper (or bronze) condenser tubes would tend to cause rapid corrosion of the aluminum in the tower. Aluminum spray nozzles have been destroyed in twelve months of operation from this cause; and brass, or glazed earthenware nozzles are now preferred.

Progress is being made in the design of more efficient and durable packings; furthermore, the no-maintenance hyperbolic cooling tower that has a working life of over 30 years (at a competitive cost) is already within sight. THE END

Fig. 1. Shop foreman performs a final micrometer inspection of one of the heavy Y-shaped integral pipe sections that was fabricated for the TVA's Widow's Creek Project. Quality control includes many other such inspections to insure precision at the check points all during the fabrication. Piping was fabricated entirely by National Valve and Mfg Co (NAVCO), of Pittsburgh, Penna. Operation begins this September

High-Pressure Piping At Widow's Creek

More than 600 tons of power piping, fittings, and hangers will be used for the world's largest single-unit steam turbine-generator, TVA's Unit Seven, at Widow's Creek facility in Bridgeport, Ala

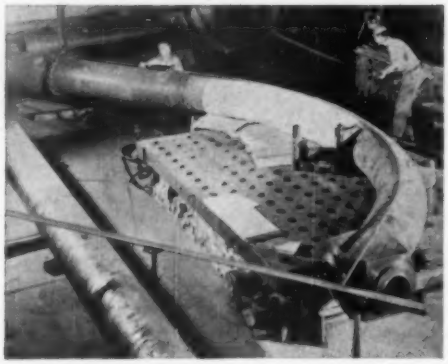


Fig. 2 shows the final squaring operation on this unusual fabricated Y-shaped integral pipe

DESIGNED to produce 500,000 kw, the boiler will be rated at 3,850,000 lb per hr, with the main lines designed for steam at 1053 F at 2600 psi. The reheat cycle will be 1003 F at 490 psi. The addition of this unit will increase the total station capability to 1,250,000 kw.

Main steam power piping was fabricated from 2¼ per cent chrome moly alloy A-369 FP-22, forged and bored, pipe. There were 14 sections of main steam line, some of which weigh more than 20 tons each. There were 323 ft of 21¾-in. O. D. by 3⅞-in. wall pipe — weighing 248,000 lb, and 195 ft of 22¼-in. O. D. by 4⅛-in. wall pipe — weighing 161,000 lb.

Pipe sections containing flow nozzles were honed to hold diameters down to a plus 0.000, minus 0.005-in. tolerance. Piping for the bend sections was provided with additional wall thickness to compensate for *thinning* on the outer arc of the band.

On the hot reheat system, the 16 sections were made of A-155, Class I 1¼ per cent chrome moly alloy. This piping, rolled from plate, was butt-welded and radiographed. This piping consisted of 256 ft of 24-in. O. D. by ⅞-in. wall, 200 ft of 24-in. O. D. by 15/16-in. wall, and 51 ft of 18-in. O. D. by ¾-in. wall, for a total weight of 109,040 lb.

Boiler feed discharge, made of A-106 GrB carbon steel, was designed for 2975 psi at 683 F. This consisted of 1160 ft of 14-in. O. D. by 1 1/16-in. minimum wall thickness, and 240 ft of 10¾-in. O. D. by 1⅛-in. minimum wall thickness. This pipe, made of seamless tubing, and the necessary fittings, weighs a total of 330,000 lb.

Counterpoise hangers were employed as the reliable constant support for heavy wall steam piping. Some are rated for individual loads as high as 19,000 lb, with a 3½-in. movement. Horizontal movement planes required the use of Levelglides to provide low friction, maintenance-free operation. A total of 130 Counterpoise hangers and 20 Levelglides were used for TVA's Unit Seven.

Because cleanliness of fabrication and erection play such an important role in power generation, painstaking care and inspection were followed to insure against scale and grit that could cause costly turbine blade repair, and loss of capacity due to outage.

All the closed-circuit piping system, composed of main steam, hot reheat, cold reheat, boiler-feed discharge, extraction and condensation services, was cleaned internally to a bright finish prior to fabrication. Mechanical cleaning was used, after completion of fabricated assemblies, to insure maximum cleanliness.

Valves for this plant vary from ½-in. globe valve (weighing four lb), to the main steam turbine stop-valves, which weigh 14,000 lb each.

Pressure and temperature requirements, for main steam services, are beyond the permissible limits for 2500-psi standard valve ratings, and require the use of stainless steel for this service. THE END

Here's Another Critique on Power Field Automation

By GEOFFREY POST

Vice President of the Genesys Corporation

Another top authority in the computer and controls field comments on some of the views in the Janaury *Automation in the Power Field* issue. He cites differences with some of the various points raised, and also presents his arguments

IT IS REALLY not enough to say that there are analog and digital computers and that they have certain general attributes. I think the main definition of *what is a computer* should not stop at all with the comparisons of an analog or a digital format, or of any special-purpose computer. It should be defined in terms of system requirements for the power industry.

For example, I think the best definition of a computer in terms of control (and not in terms of data processing) is "that part of the control system which performs the evaluation, and the decision and control functions, either through the actions of an operator reading results, or directing the actuators on-line." Then, it can be stated that computers are analog, they are digital, they are sometimes hybrid, or they are sometimes digital-incremental. For any given power system control problem, any one of these can be applicable and useful, and the choice of which and how and when depends on these five points:

1. The economics of the problem; 2. sophistication of control desired; 3. flexibility of control desired; 4. skill level of operating personnel; and 5. how far computer will go in making decisions before the human supervisor comes into the problem.

While the automation issue pointed out what a computer *can* do, it did not really express what a computer *cannot* do. Examples given defining the costs of a typical computer system for the power industry really are specifically along the lines of a general-purpose digital computer. This pricing would not be realistic for an analog computer, or some special-purpose digital computers, and therefore is subject to some question.

I think one very important point that was missed on the functions computers *can* perform, even with on-line application, is that they can be used as an analytical instrument to help you to find out more about your control needs — which may be poorly defined in the early stages of control. This particular point is something that few people think about, and it represents the key to optimum control for the complex multi-variable system.

One point that was not stressed, and, I think, would have been of great interest to the power engineering field, is how programming can be simplified to the point of "feeling" control on-line, so that behavior patterns can be evaluated in terms of computer functions.

I disagree with the point made in one paper that to install an electronic solid-state analog control system is a suggested logical step to optimal control. It just depends on the system requirements, and it is probably not a logical step for the majority of systems.

Furthermore, it is stated that another logical step to optimal control is to install a solid-state scanning and logging data system. This may be very well if the reliability requirements and price and economic justification are there. This particular system may run very well using mercury relays and stepping-switches if the speeds are such to allow a long life for this type of operation, as a great deal of money can be saved by this approach.

How does one decide whether one should have a computer or a data-logger, or both, and when? This was an important point left unanswered. Instead of stating what one should do for a given problem, and how one should really justify the use of a data-logger (and understand its real function in supervisory control and application to the type power system problem), it is pointed out: "do this and your problem is solved."

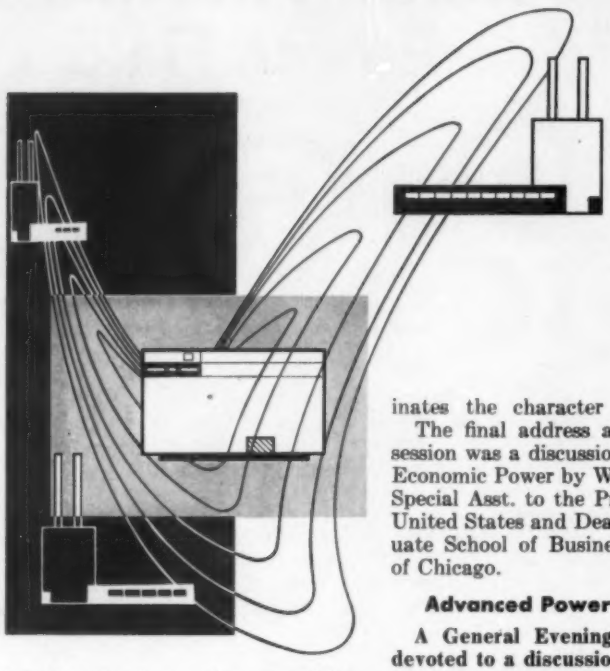
IT IS STRESSED that there is a need to apply a digital computer rather than to design a system to control instrumentation problems. The tremendous accuracy of the digital computer is spoken of, as opposed to the best transducers or measuring devices. Who wants to buy a Cadillac to do the job that requires only a Ford? What is really needed is a computer which is compatible with the requirements of today's best transducers and measuring devices, and yet better enough in accuracy so that it doesn't add any great inaccuracies to the system's operation or control.

In my opinion, the following statement made in a computer evaluation paper is quite incorrect: "These dead times (response-time lags) stymie the computer and are often a critical limiting factor in the dynamic response of an instrument plant." While they may be often the critical limiting factor in the dynamic response of a well-instrumented plant, they certainly do not stymie the computer. Knowing something about the response lag, or dead time of a system, there are very excellent methods for accounting for these lags and servo-ing around them in terms of control operation.

This article concludes our series of critiques of the January, 1960, issue of POWER ENGINEERING.

APC Foresees Many Changing Shapes

Need for more and better sources of power is the challenge of the future, when expanding industry and an ever-growing populace will realize more than ever that the nation's—and the world's—economy is indeed dependent on power development



MORE THAN 3000 power engineers met at the 22nd American Power Conference in Chicago's Hotel Sherman, March 29–31. In over 30 sessions, they discussed current problems and heard of the changing shapes and dynamic new concepts in the field. The yearly conference is unique in that it is the only one devoted entirely to the problems of the power engineer. Many conceded it to be the best balanced program in years.

Opening Meeting

The three addresses at the opening session on Tuesday morning, March 29, were of general but varied interest, ranging in scope from a history of naval nuclear submarine propulsion to a critical discussion of the morality of the profit system.

The address by the Honorable James Wakelin, Jr., the Asst. Sec. of Research and Development, Dept of the Navy, on "The Development of Nuclear Propulsion in the Navy" was of interest because it described the very early history of the atomic submarine program. Although the events in this program during the last seven years are fairly well known, much of what went on in the period between 1946 and 1952 is obscured by the fact that it was done under a heavy veil of secrecy.

An interesting point which Mr. Wakelin brought out was the fact that the Navy first conceived the idea of a nuclear-powered submarine in 1939, at a time when the principle of a controlled nuclear chain reaction had not even been proved. During the early stage of the work, the Naval Research Laboratory program was based on an educated guess, since all of the technical information on the possible development of nuclear power was locked up in the files of the Manhattan District.

In the years that followed there were many vexing problems, delays, and frustrations in the Navy's attempt to develop nuclear propulsion, but all in all it was a magnificent coöperative achievement by many people in many places.

Less inspirational in its content than the discussion on the Navy's nuclear propulsion program but of disturbing significance was the address, "The Morality of the Profit System" by John Conrad, President of S & C Electric Co. As Mr. Conrad indicated in his opening remarks, he was under a compulsion to speak out for what might be a lost cause. He did not accept the optimistic predictions that the "Soaring Sixties" are an accomplished fact. He felt that the degree of morality that we will attach to the concept of profit during the Sixties will determine the degree of prosperity we will achieve. He had a sense of ominous foreboding that this decade could go down in history as the Sorry Sixties.

The questions concerning the morality of profit are these: Will we feel good about profit in the Sixties? Will we seek profit with pride, or will we apologize for profit? Among the factors involved in Mr. Conrad's discussion of the morality of profit were such things as the attitude of business toward tax evasion involving business entertainment, the use of private yachts, hunting lodges, payola parties, and convention junkets. The wastefulness of these practices, Mr. Conrad pointed out, has an abandon about it which contaminates the character of a people.

The final address at the opening session was a discussion of American Economic Power by W. Allen Wallis, Special Asst. to the President of the United States and Dean of the Graduate School of Business, University of Chicago.

Advanced Power Concepts

A General Evening Session was devoted to a discussion of advanced power concepts. These included a brief presentation of the principle of magnetohydrodynamics (MHD) and the possibility of using it in a commercial power cycle, by Arthur Kantrowitz of the Avco-Everett Research Laboratory; the use of Isotopic Heat and Power, by Douglas Harvey of the Martin Nuclear Division; and, a description of The Nuclear Rocket, by Lt. Col. Howard Schmidt and Major Ralph Decker, both of the USAF. The MHD principle was presented in the April issue of POWER ENGINEERING, page 72, and, as indicated in that article by John Yellott, it has attractive possibilities for future power generation.

The use of radioactive isotopes provides self-contained sources of energy in relatively high power densities which have potential application wherever small power sources are required over long periods of time, particularly in space vehicles. As was indicated in the paper, every space vehicle requiring a long-lived, light, reliable power plant in the range of 1 to 500 watts is a potential user of these isotopic power plants. Such sources need not be limited to the power output of the power plant itself, provided the power requirement is cyclic. In this case, the energy may be stored in a battery bank and released in short bursts of high power. The authors described the first isotopic power source in detail; this is SNAP-IIIB, which uses

polonium-210 as fuel. SNAP-IIIB has a capacity of 10,000 watt-hours (over a period of 280 days). A conventional battery equivalent would consist of 160 lb of zinc-silver cells.

The final paper at the General Evening Session described quite a different kind of a power plant as compared with SNAP-IIIB. This is the Kiwi-A reactor, developed in the Project Rover under the Nuclear Aircraft Propulsion Program. In a humorous vein, this reactor was named Kiwi-A after the flightless Australian bird.

The design of this reactor is quite simple. It consists simply of a reactor core containing nuclear fuel elements, through which hydrogen gas (derived from a tank of liquid hydrogen) is pumped and, by virtue of the nuclear heat, is raised to a high temperature. The consequent thermal expansion raises the gas to a high pressure, and it is emitted through a hydrogen-cooled nozzle.

The Nuclear Sessions

Of considerable interest at the nuclear sessions was the progress report on the Dresden Nuclear Power Plant, by J. J. Poer of the Commonwealth Edison Co and V. D. Nixon of the General Electric Co. Dresden station, which is located 47 miles southwest of Chicago and is the largest all-nuclear plant in the United States, has virtually been completed and the reactor is now being brought up to power. The Dresden reactor first reached criticality on October 15, 1959, after the first 28 fuel assemblies had been loaded into the core.

Shortly after fuel loading of the reactor had begun last October, trouble was experienced with the mechanical control rods, and the loading program was suspended until the difficulties were corrected. The trouble was of a relatively minor nature, and after it had been corrected, loading was resumed. During February, critical testing was completed at three levels, one with 144 fuel assemblies, another with 256, and a third with 320. From March 4 to March 14, loading was continued with various configurations until finally the full loading of 448 elements was achieved. On the day of the presentation of the report by Mr. Poer and Mr. Nixon, the reactor began developing power for the first time. During the summer, critical testing will continue, and it is expected that Dresden will be connected to the Commonwealth system some time late this year.

Another paper of interest at the nuclear sessions was one on Economic Atomic Power, by W. L. Budge and B. L. Lloyd, both of Westinghouse. The theme of this paper was that nuclear power plants should be fitted into existing electric utility systems on the basis of total system costs, and not merely on the costs within the alternative plants (nuclear vs conventional) under consideration. Messrs. Budge and Lloyd put forth the idea that in most systems where nuclear plants are competitive, the best future economic pattern will contain an optimized combination of nuclear and conventional plants. For most systems, nuclear plants will take over the base load, the high load factor portion of the load duration curve, and the conventional fuel plants will serve the upper portion of the load curve.

The authors of this paper also indicated that, based on the cost-versus-size relationship for nuclear and conventional plants, it appears that for some time to come, nuclear plants will prove competitive only in the very large sizes, 300 Mw and over.

One of the factors that has retarded the more rapid application of nuclear power in the utility industry is the relatively poor quality of the steam produced by nuclear plants, *i.e.*, saturated steam at relatively low pressures and temperatures. For this reason, the paper by C. R. Braun and C. B. Graham, both of Allis-Chalmers Mfg Co, was of interest because they described the development of the integral nuclear superheat reactor being developed for the Pathfinder Atomic Power Plant under construction for Northern States Power Co near Bismarck, N. D.

This will be the first large boiling-water reactor using an integral superheater to be built for commercial service. The reactor will be designed for a heat power level of 157,200 kw in the boiling region, with a circulation of 60,000 gpm. The steam generation rate will be approximately 618,500 lb per hr at an operating pressure of 600 psig and a temperature of 489 F in the boiling region. Then the integral nuclear superheater will raise the steam temperature to 825 F, with a pressure drop of 60 psi or less. The total plant output will be 196,000 kw (thermal) with the turbine-generator producing a total 66,000 gross electrical kilowatts.

The three papers discussed above were all presented at the first nuclear session. The second nuclear session was devoted to new reactor concepts and to the use of nuclear heat in industry. The latter paper was presented by Frank Pittman, Director of the Division of Reactor Development of the AEC.

Messrs. Rhode, Roberts, Schluderberg, and Walsh of Babcock & Wilcox Co's Atomic Energy Division discussed experiments on the feasibility of gas-suspension coolants in nuclear reactors. This concept involves the use of an inert gas coolant such as helium, nitrogen, or argon, carrying in suspension finely-divided graphite. Such a coolant would result in improved heat transfer and lower fuel element surface temperatures while at the same time reducing equipment cost.

Another novel reactor concept described at the second nuclear session was the Liquid Fluidized Bed Reactor Program being conducted by the Martin Nuclear Division. This project was described by Martin R. Scheve of Martin. In this concept, the fissionable fuel is to be in the form of pellets completely immersed in water. When the reactor is not in operation, the pellets rest on a perforated plate with holes large enough to permit rapid water flow but small enough to keep the pellets from falling through. In this "collapsed" state, the quantity of U^{235} in the bed of pellets is below critical mass and will not support a chain reaction. However, when the pumps cause the liquid to surge upward, the pellets will tend to rise and separate from one another, and the increased moderating effect of the water will then produce the desired chain reaction.

Peak Power Generation

Interest in economical peak-shaving methods by utility companies was reflected in an entire session on the subject. First, A. G. Mellor and W. D. Marsh of General Electric presented new generation concepts in higher temperature and pressure conventional steam units, combined gas-turbine-steam-turbine plants, and spinning reserve generating units. They then discussed methods of peaking generation. These include: hydro power; pumped storage hydro; low-cost steam plants; gas turbine or diesel plants. Examples of each were given.

L. B. LeVesconte and Tor Kolflat of Sargent and Lundy showed how margins built into power plant equipment often provide peak capacity; also how pool interchange arrangements often permit peak capacity to be purchased for about $20 per kw per year demand charge. Increase in size of contemplated units may provide peak capacity for about $80 per kw. Low-cost, low-efficiency steam plants for peaking may give a saving of 20 to 23 per cent in capital cost, compared to same-size efficient units.

Built-in, short-time peak capacity of 10 to 20 per cent in new plants may be obtained by shutting off feedwater heaters, increasing steam pressure, by-passing turbine high-pressure end, changing fuel during peak hours, and so on. Pumped storage and gas turbines for peaking offer possibilities.

Alternate methods were also discussed by F. A. Ritchings and R. R. Bennett of Ebasco Services. Assuming a 250-Mw, 2000-psig, 1000/1000-F unit, they discussed how

Continued on page 90

Automation Leaders Discuss the Future

POWER ENGINEERING editors and authors exchange candid views on present status of automation developments within the power industry

AT THE SHERMAN HOTEL in Chicago on March 28, on the eve of the American Power Conference, a number of leaders of the automation industry met at dinner with the editors of POWER ENGINEERING to discuss the trend for this important area in the power field.

Those attending were: Tom Nourse of Hagan, Al Sperry of Information Services, Carl Fleming of Foxboro, Byron Morehouse of Leeds and Northrup, Dick Mays of Bailey, Paul Miller of Daystrom, Prof. Bob Szewalski of Poland, and Jeff Hunnicutt of T-R-W, and formerly of POWER ENGINEERING.

Most of these men were authors of articles published in the January, 1960, issue of POWER ENGINEERING, which was given over to a comprehensive look at automation in the power field.

All were most complimentary about Ebasco's specifications for the new Goldsboro Station addition of Carolina Power & Light. These were prepared by Bill Summers, also one of the January Special authors. It was generally agreed that these specifications define the automation problem for a modern power plant very thoroughly, in a way that could not have been done 12 or 18 months ago.

These Goldsboro specifications aim at solving three separate and distinct problems simultaneously: first, automatic start-up and shutdown; second, optimize on-line operation; third, maintain a tremendous amount of historical data.

Point was made that progress in power plant automation has been most rapid in what is probably the most difficult phase — load dispatching and system control. Also, that progress has lagged most in what should have been the simplest phase — control of the boiler and generator unit.

There was considerable discussion of the ease, or difficulty, of controlling boilers, and some felt that the dynamics of boilers are better understood by European manufacturers than by the American companies.

POWER ENGINEERING editors and guests, left to right: Dick Mays (Bailey), Dick Morris, Byron Morehouse (L&N), Paul Miller (Daystrom), Tom Nourse (Hagan), Bob McCaw, Al Sperry (Info. Services), Jeff Hunnicutt (T-R-W), Chester Earle, Carl Fleming (Foxboro), Andy Kramer, Bob Szewalski and Welden Reynolds

It was plain that there is not much clarity yet as to just what a computer is expected to accomplish in maintaining optimum on-line operation. Some felt that the computer, to do the maximum job, must be able to correct and locate any deviation from the optimum. But no one knows how many characters (on the computer) may be involved in programming a station computer control for optimization.

There was talk about the economics of automation, several maintaining that the real push among certain companies was continued operation in the face of possible labor difficulties. But on the whole, the experts are surprised by the rapid acceptance of automation, and the computer, by the power industry. Acceptance by management — of research as a management tool — was given some credit for this situation.

There was some difference of opinion on the prospect of a very rapid development for automation. Some felt that the entire industry, users as well as suppliers, are paying for past sins or neglect; and that the lag is forcing a much-needed integration of all the elements making up a power system.

Enthusiasm shown by the group certainly indicates the dynamic status of Automation in the power field.

POWER ENGINEERING editors attending the dinner meeting were Chester Earle, Andy Kramer, Bob McCaw, Dick Morris and Welden Reynolds.

Power Engineering handbook

Do you understand those "Dangerous Conditions" in Steam Operation?

By BERT H. McHENRY*

A DANGEROUS CONDITION is one which will weaken or damage any part of the boiler or heating system so that it is not safe to operate. Terms applied to the most common dangerous conditions are: overpressure; dangerous low water level; firebox explosions.

The operator must know what these are, what they do, how they are caused, and how to prevent or handle them.

Overpressure

Pressure is safe only when it is kept at a low enough value to prevent damage to the vessel or equipment in which it is confined. Whenever a pressure is higher than a safe value, an overpressure condition exists.

"Maximum allowed pressure" is the highest value of steam pressure permissible for a boiler. The "design strength" of a new boiler is usually about five times the amount necessary for the maximum allowed pressure. Boilers are tested by the manufacturer at the shop where they are made, under a 60-psi water pressure test. After a boiler is in use, water pressure tests (hydrostatic tests) are made up to 1½ times the maximum allowed pressure. To be completely safe, an operator should keep his operating pressure a few pounds per square inch below maximum allowed pressure.

After a boiler is in service for some time, weaknesses in construction may occur. Continual heating and cooling of the metal cause fatigue. Rusting and pitting of metal weakens its strength. From these and other causes, the boiler gradually becomes less and less able to take undue stresses. At the same time, the safety devices become old, if they have not been tested frequently, and are liable to fail when needed.

Steam pressure is kept at proper values by the operator watching the steam gage and shutting off the fire when a set value is reached. Some boilers have automatic controls such as a pressurestat, which shuts the fire off when a set pressure is reached.

If the operator does not shut off the fire, or the pressurestat does not work, the safety valve is supposed to release and let off steam when pressure reaches maximum value. If the safety valve doesn't release, or is too small for the boiler, an overpressure condition occurs.

If this should happen, shut off the fire, change nothing, leave the boiler room, and contact the boiler inspector. If the overpressure condition is much over the maximum pressure allowed on the boiler, it is advisable to warn anyone in the vicinity of the condition, so they can leave the area until the steam pressure lowers to a safe value.

Do not attempt to relieve pressure suddenly on a boiler that has been subjected to an overpressure condition, by pulling the safety valve manually or by opening additional valves to let out steam. Do not attempt to operate the boiler again until it has been inspected carefully by an authorized inspector.

Many untrained operators try to pull the safety valve manually when an overpressure condition exists. By doing this, more damage can be caused than would occur if the boiler were shut off and allowed to cool by itself.

Boiler and heating system are already strained to their maximum when an overpressure condition exists. Even with this strained condition, however, the fact that the boiler has not blown up shows that the boiler and system are still retaining the pressure. The pressure-temperature balance is still quite stable and the water in the boiler is boiling gently, producing a steady, uniform amount of steam.

Should steam or water be released suddenly from the boiler, this temperature-pressure relationship would be upset and the heat in the water would cause sudden and rapid boiling, with the resultant formation of great quantities of steam. This rapid boiling would continue until the water cooled to a temperature proper for the steam pressure. This rapid boiling action and the great quantity of steam produced would cause the boiler to vibrate and strain weak points, which could crack.

Merely by shutting off the fire and allowing the boiler to reduce gently in temperature and pressure, no violent boiling or shaking of the boiler occurs. The boiler then cools down with little or no additional damage or increased danger of an explosion.

Proper time to pull the safety valve manually is at either normal operating pressure or at the maximum operating pressure of the boiler. Careful attention to this will prevent an overpressure condition from occurring.

After an overpressure condition occurs, have the boiler checked for damage by a boiler inspector. He is skilled in inspecting the equipment and can tell whether or not damage has occurred.

*Engineer Examiner, City of Seattle. Republication rights reserved by the author

POWER ENGINEERING HANDBOOK

This article is taken from a book which the author is preparing as a beginner's guide to low-pressure steam operation. Other chapters take up steam heat and the steam operator, boilers and boiler terms, standard safety controls, feedwater regulation and low water controls, combustion and fire controls, cleaning operations, the service agency, boiler inspectors and inspections, instruction methods, license examinations, license laws and procedures.

Dangerous Low Water

Normal water level in a boiler is above the bottom of the water gage glass and below the top. When the water drops out of sight in the gage glass, with the fire burning, a low water condition occurs. Should any fire surfaces be left without water surrounding them to accept the heat, they would soon become very hot and be weakened considerably.

To be safe, when water is out of sight in the gage glass and the fire is still burning, shut off the fire, change nothing, and notify the boiler inspector.

Do not add water to a boiler that has a low water condition on it.

If the boiler were still hot and water were added, the fire surfaces would be subject to severe damage from water hitting them. Even water at 250 F would be extremely cool to firetubes or other metal surfaces heated to 800 or 1000 F by heat from the firebox. Once heated to that point, contact with water will cause sudden contraction, with a possibility of cracking.

After a low water condition has occurred and the boiler has cooled, do not change the water level until the inspector can check the actual level of water. It may be that the water level was not yet low enough to cause severe damage.

Do not attempt to operate a boiler that has been subjected to a low water condition. Proper inspection can be performed only by competent inspectors and is not a function of the operator.

Firebox Explosions

Firebox explosions or "flarebacks" are normally caused by oil or gas vapors being lit in a hot firebox. Minor ones

occur frequently, while major ones, with disastrous results, occur only occasionally. Most major ones have usually been preceded by many minor ones, although this is not always the case.

Should a liquid- or gas-fueled fire go out when it is first lit, wait until the firebox has cooled considerably and the hot gases have had a chance to escape, before relighting it.

Oil and gas vapors, when hot, are very explosive in a confined space. A small spark can touch off hot oil and gas vapors which require an actual flame when the fuels are cold.

Firebox explosions and flarebacks are very unusual on clean, well-cared-for and properly adjusted burners. Most of them can be reduced or eliminated by a careful, fully-informed operator.

Some are caused by trying to light a burner too soon after it has gone out, without sufficient "purging" (blowing out of hot gases), or without sufficient cooling. Most automatic burners are regulated so that the air blower turns on for a short period of time before the fire is ignited. This allows the firebox to cool and purge itself prior to readmitting the flame.

Some firebox explosions are caused by short stoppages of fuel flow to the firebox, and then the fuel comes back on suddenly and lights from sparks remaining in the firebox. Some explosions are caused by the cycling controls being out of adjustment and not turning on the blower in advance of the fuel and flame. On boilers where modulating controls provide a low and high fire sequence, some explosions are caused by the high fire sequence turning on first.

Dirty nozzles, igniters, oil lines, filters, controls and surfaces in the firebox, heating surfaces and stack, as well as poorly adjusted air and fuel mixtures, all contribute to firebox explosions. Some have even been caused by hot gases from a separate boiler, connected to the same stack, producing gases which flow into the firebox of a cold boiler and cause it to explode when lit.

Minor flarebacks are signs of danger and should be corrected to prevent major firebox explosions. Correcting the cause requires thinking out the possible sources of difficulty, checking each possibility to determine if it is the cause, isolating the cause and finally correcting it.

Any serious or major firebox explosion requires careful inspection by the boiler or insurance inspector before operating a boiler again. Any minor malfunction of the burner or controls and indications of poor starting or burning of the fire should be taken care of immediately rather than waiting for a serious explosion.

Do not light a hot firebox.

Do not allow your burner to get into a poorly cleaned or poorly adjusted state.

Check your safety controls to be sure they are functioning properly.

Report any flarebacks to your service agency and firebox explosions to your inspector.

Heat Transmission Through Sheet Metal Ducts

By JOHN D. CONSTANCE, P.E.

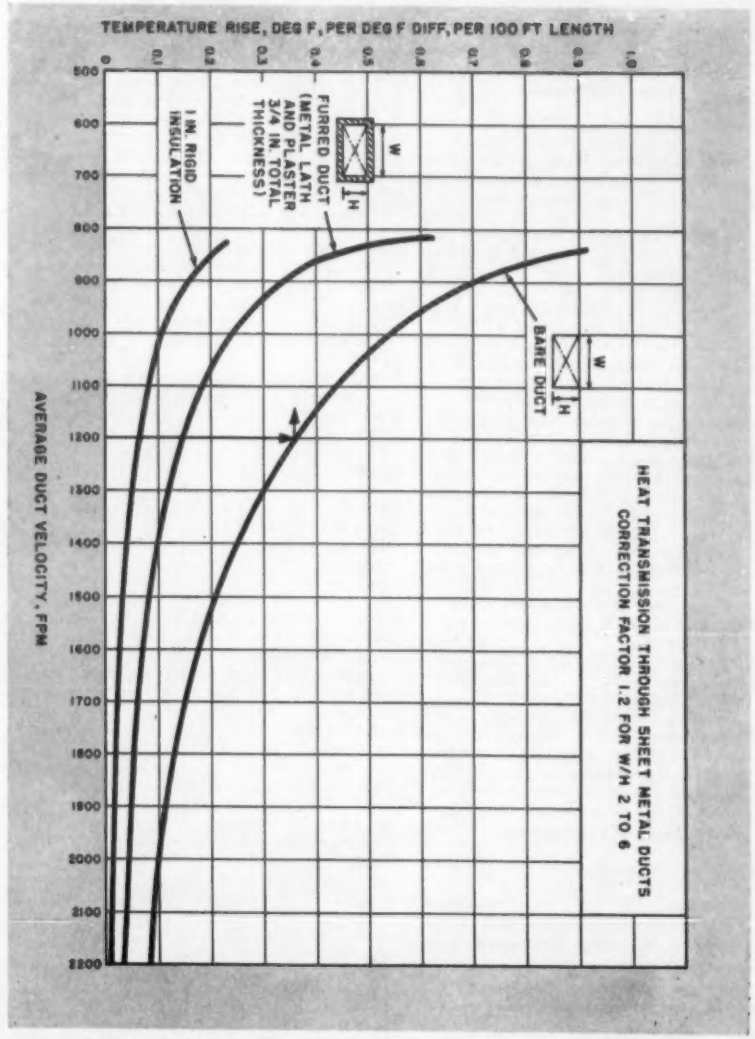
YOU HAVE INSTALLED a forced air heating system in your plant and now you must decide whether to leave the ducts bare or insulate them against heat loss.

Normally, temperature drop will vary from 2 to 5 F for a duct run, and if greater than 5 F you should consider insulation or furring. We are not here concerned with types of insulation, but to see if we should insulate. To do this, use the chart on the page opposite.

The family of curves gives a quick visual appreciation of the effect of air velocity on temperature drop inside ducts with still air on the outside. Note that the greatest drop takes place at relatively low air velocities; at higher velocities it may not pay to insulate or furr in ducts. This decision can only be reached by a detailed study of the duct layout.

Multiplier corrects for ducts with rectangular cross-sections.

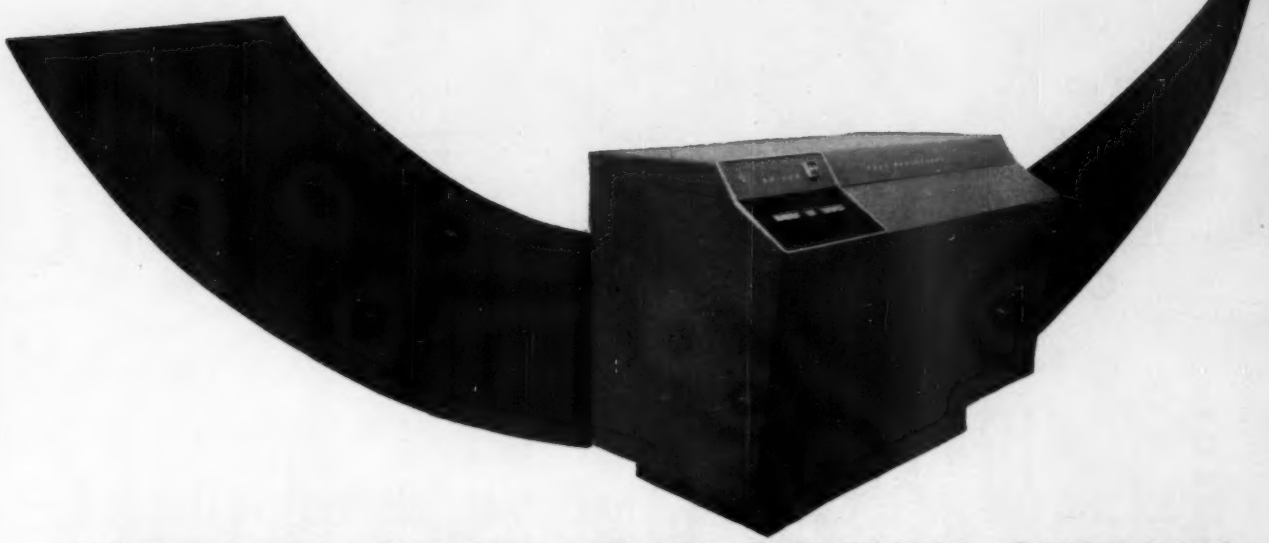
fold along this line—outside edges toward you



Example: Duct 24 in. wide by 12 in. high, W/H equals 2. Length is 75 ft. Air in duct is 120 F, surroundings are 50 F. Find temperature at end of duct run, if duct velocity is 1200 fpm. Solution: from curve for bare duct, factor is 0.36. Then 0.36 x 1.2 x 75/100 x (120 — 50) equals 22.68 F, or say 23 F temperature drop. Air leaves duct at 120 minus 23 or 97 F. The question is, should we insulate?

cut along this line

Two industry leaders close the loop to give you...



COMPUTER COMBUSTION CONTROL SYSTEMS

REPUBLIC FLOW METERS CO., the leader in electronic combustion control, and the THOMPSON-RAMO-WOOLDRIDGE PRODUCTS COMPANY, the leader in computer process control and manufacturer of the outstanding RW-300 Digital Control Computer, have "closed the loop." Through a co-operative plan, they have created a unique pool of engineering experience to give you these important advantages when planning automated power plants:

—coordinated sales service
—coordinated engineering service
—coordinated installation and operation service

Republic Flow Meters Co. (a subsidiary of Rockwell Manufacturing Company) has been a leader in pneumatic combustion control systems for over a quarter of a century, and during the last 10 years has designed over 125 electronic combustion control systems for steam generating plants. Republic engineering experience and product reliability in combustion control, feedwater control, superheat and reheat control, is assurance of system reliability.

Thompson-Ramo-Wooldridge Products Company (a division of Thompson Ramo Wooldridge, Inc.) has been the leader in developing industrial computer control systems for over five years. The RW-300 Digital Control Computer, designed specifically for closed loop control and on-line data reduction, has demonstrated around-the-clock reliability in 14 industrial installations.

These two leading companies now offer coordinated engineering, installation and service for completely integrated control systems. Sales engineers located in principal cities throughout the nation can provide details of this cooperative plan, or either company may be contacted directly—Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Illinois—The Thompson-Ramo-Wooldridge Products Company, 202 North Canon Drive, Beverly Hills, California.

REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

For more data circle 530 on Post Card

What's Your Diesel I. Q.?

These self-evaluation examination questions are taken from a home study course developed coöperatively by Interstate Training Service and Cummins Engine Co. For answers, turn to page 86.

1. Are all engines internal combustion engines? ———Yes———No

2. Name the three basic parts which form the combustion chamber. a.——— b.——— c.———

3. Should the cylinders in a new engine be slightly larger at the top than at the bottom? ———Yes———No

4. That part of the crankshaft to which the connecting rod is assembled is called the ———————

5. How many revolutions would the crankshaft of a 6-cylinder, 4-stroke cycle diesel engine turn to fire all of the cylinders once? ———————

6. Circle the terms that are common in both gasoline and diesel engine operation.

Crankshaft	Ignition Coil
Carburetor	Cylinder Head
Push Rods	Cetane Rating

7. How many lobes does the camshaft of a 6-cylinder Cummins engine have? ———

8. Check the principal cause of detonation in a diesel engine.
———Loose Piston Pins
———Ignition Lag
———Bent Con Rod

9. Black exhaust smoke from a diesel engine indicates: (check one)
———————Too much air taken into combustion chamber.
———————Too much fuel injected into the combustion chamber.

10. The camshaft of a 4-stroke cycle engine rotates at what speed? (check one)
———Twice crankshaft speed.
———Crankshaft speed.
———One-half crankshaft speed.

11. When the piston in a 4-stroke cycle engine is moving up in the compression stroke, what is the position of the valves? (check one)
———Both the intake and exhaust valves are closed.
———Both the intake and exhaust valves are open.
———The intake valve is open and the exhaust valve is closed.

12. If a diesel engine is operating correctly at normal load, and complete combustion is taking place, the exhaust should be: (check one)
———————Black———————Gray
———————Barely visible haze.

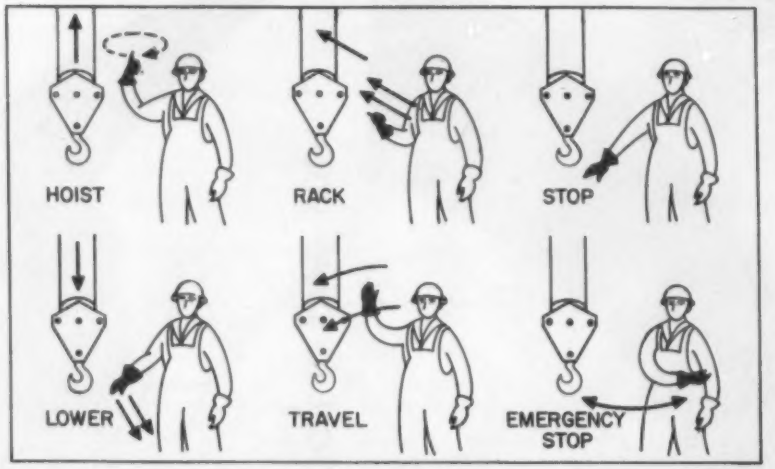
13. In a 6-cylinder 4-stroke cycle engine running at 2000 rpm, a single cylinder will fire as many times as: (check one)
———6 times per second
———17 times per second
———150 times per second
———333 times per second

14. Heat of compression is caused by: (check one)———Hot exhaust gases.
———————Friction of the piston against the cylinder wall.
———————Molecular friction.

15. The heat value of a diesel fuel is measured in: (check one)
———Cetane rating
———Octane rating
———Btu's———B.M.E.P.'s.

16. The order in which the strokes of a 4-stroke cycle engine occur is: (check one)
———Intake, power, compression, exhaust
———Power, exhaust, intake, compression
———Compression, power, intake, exhaust
———Intake, compression, exhaust, power

fold along this line—outside edges toward you



Standard crane signals for rigger, hookers and erectors. There should be only one authorized signalman

Know Your Crane Signals

By PAUL C. ZIEMKE

ACCIDENT RECORDS of the large insurance companies are replete with information on the frequency of serious injuries to personnel and damage to valuable property through errors in crane control brought about by misunderstood or wrongly sent signals. Then, too, crane operators are often confused by conflicting orders.

Only one person should be authorized to give signals, and he should be readily identified by a distinctively marked safety hat, arm band or jacket. It has been noted by a consensus of opinion taken from many crane operators that hand signals are more readily read if the signalman is wearing a glove or mitten. Apparently the bulk involved is the factor here.

There is one exception to the rule of only-one-man-signaling. In an emergency the crane operator should recognize an emergency signal from *anyone!*

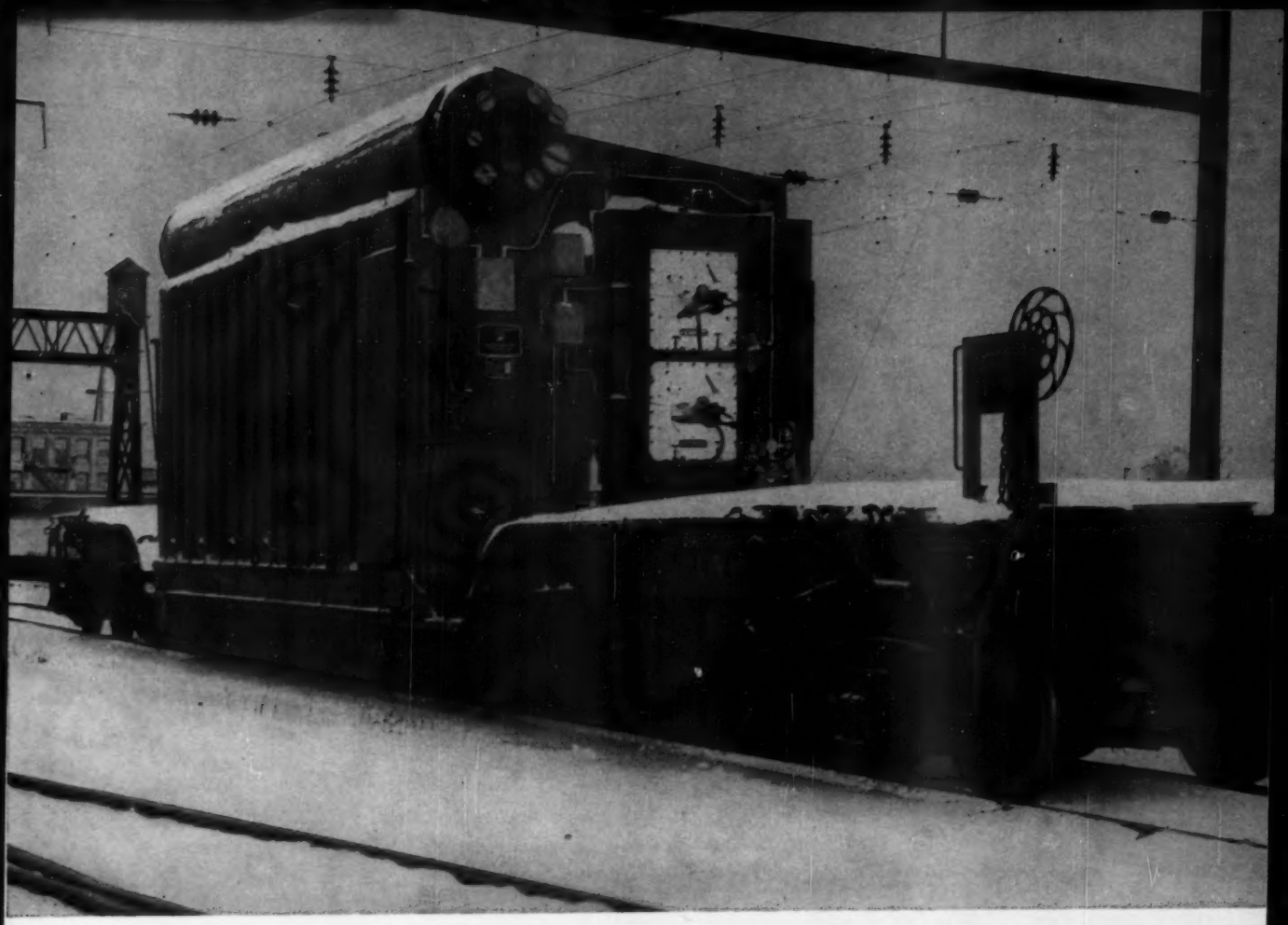
When two cranes are operating as a unit, the concerted effort of both operators must be directed by *one signalman* lest the slightest error in movement occur.

The crane should be centered over the load before lifting, to prevent swinging it. Ordinarily, loads should not be swung by the crane to reach areas not directly below crane travel. Exceptions are where such items as bundled tires, coils of rope, or bales of hay and cotton are swung into side areas. Dangers of the operation are the hazard to riggers of rolling commodities, and the probability of the crane carriage (trolley) striking the rail stops too viciously. Everyone in the immediate area should get in the clear before a load is moved, raised or lowered.

Loads should not be dragged unless there is an emergency, and only then with the permission of the supervisor in charge. It is also considered a hazardous operation to move material or equipment by electromagnet, since the circuit may inadvertently open at any time to drop the load. Again, under emergency conditions the magnet can be used under the direction of the assigned supervisor.

Loads should not be lifted with unused chain, rope or cable sling ends dangling loose. Load should not be carried at eye level, if possible to carry it

cut along this line



Special purpose application...a standard steam package

This Foster Wheeler packaged steam generator is standard in virtually every respect except for its unusually high design pressure. The AGX-series unit shown here will deliver over 65,000 lb of steam per hr to test high pressure steam turbines at DeLaval Steam Turbine Company, Trenton, N. J. The Foster Wheeler AGX-series packaged units are designed to operate at pressures from 901 to 1,350 psi.

Don't let out-of-the-ordinary steam requirements keep you from considering the economy and convenience of a packaged steam generator installation. The proven basic design of standard Foster Wheeler steam generators allows you wide latitude for adapting to special needs.

Look at the features you have to work with. High steam purity, generous furnace volume, highly efficient convection tube bank, liberal drum size, removable drum internals, to name only a few. All necessary standard equipment is included.

There's no better or more complete packaged steam generator design available today at a comparable cost. Write for FW bulletin PG-58-2 *before* you write specifications for *any* steam generator from 13,000 to 100,000 lb/hr capacity at pressures from 270 to 1,350 psi. Foster Wheeler Corporation, 666 Fifth Ave., New York 19, N. Y.

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

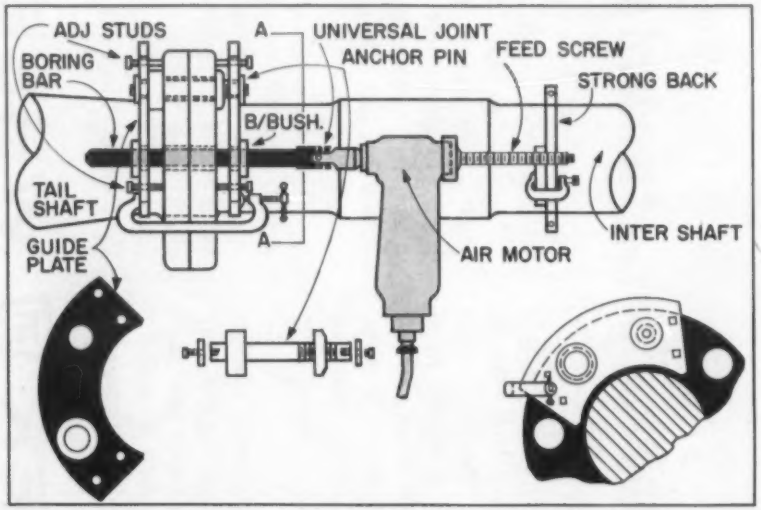
For more data circle 531 on Post Card

higher. Also, check the path of the run to be sure that the maximum height will clear all the obstructions.

Railway cars and other wheeled yard equipment should not be dragged with the crane unless a line has been reeved through a well-anchored snatch block which will permit only a vertical pull on the crane hoist.

Many plant owners find it good practice to install a handset on a line that can be lowered from the cab, which will permit telephonic communication to discuss technical details on crane lift problems. Several firms have the handset and rubber cord raised and lowered with the hook so that it is available at all times. With soft rubber cups on transmitter and receiver, the side noise on the ground level is eliminated. It is a vast improvement over handwaving and trying to shout above the racket.

New Way to Machine Bolt Holes on Flanges



Boring jig designed by Frank S. Machado for use on flanges. Use of jig eliminates reaming operation

JIG for machining bolt holes in flange couplings as a boring operation in place has been designed and built by Frank S. Machado of the Pearl Harbor Naval Shipyard. As described in the *Bureau of Ships Journal:*

Machining these bolt holes takes a high degree of accuracy in drilling and centering the bolts and bolt holes. Customary practice is to drill the hole undersize and then ream it to size in place. However, if the drilled holes do not match up perfectly, the reamer is inclined to follow out of line. In this case, it would be difficult to fit up the flanges with the body bound bolts that are being used.

The new method substitutes a boring in place for a reaming operation. Use of this method makes it possible to bore straight concentric holes in the flanges at a substantial saving in time. In addition, the boring method can be used for machining odd-sized holes and does not limit the operation to available reamer sizes.

fold along this line—outside edges toward you

Unusual Way of Pouring a Foundation

By D. K. SMITH

HERE'S a description of a method we used several months ago in pouring a foundation for a marine gear reducer we use on our 1st line 12-in. mill drive. Due to the shape of the marine gear reducer, the former foundation did not hold up. Difficulties were encountered in fabricating the form for the foundation. After a few months of use, the reducer broke loose from the foundation.

Several temporary repairs were made, each one the result of broken lead spindles and pinion spindles. As production time was involved, it was necessary to remove the old foundation and pour a new one in three days. This did not allow the time needed to fabricate a form.

We decided that the only way for us to get proper alignment and foundation shape was to suspend the gear reducer, and pour cement under and around as needed.

As the site for the reducer was located under our overhead crane way, we decided to take advantage of this situation. We suspended the gear reducer over the excavation for the new foundation. Steel bars were welded to different points to eliminate lateral sway. C-clamps were installed tight against the crane wheels to keep the crane from moving if the wind should start blowing.

We ordered the cement with 2 per cent calcium chloride, so that set-up time would be fast, and thus temperature change would not affect the hoist cables enough to distort alignment of the gear reducer.

Cement was poured and everything was started up on time and as planned. Foundation was a complete success. When gear reducer was run at full speed, there was no variation; alignment was perfect, and we have had no trouble since. Weight of the gear reducer was about three tons.

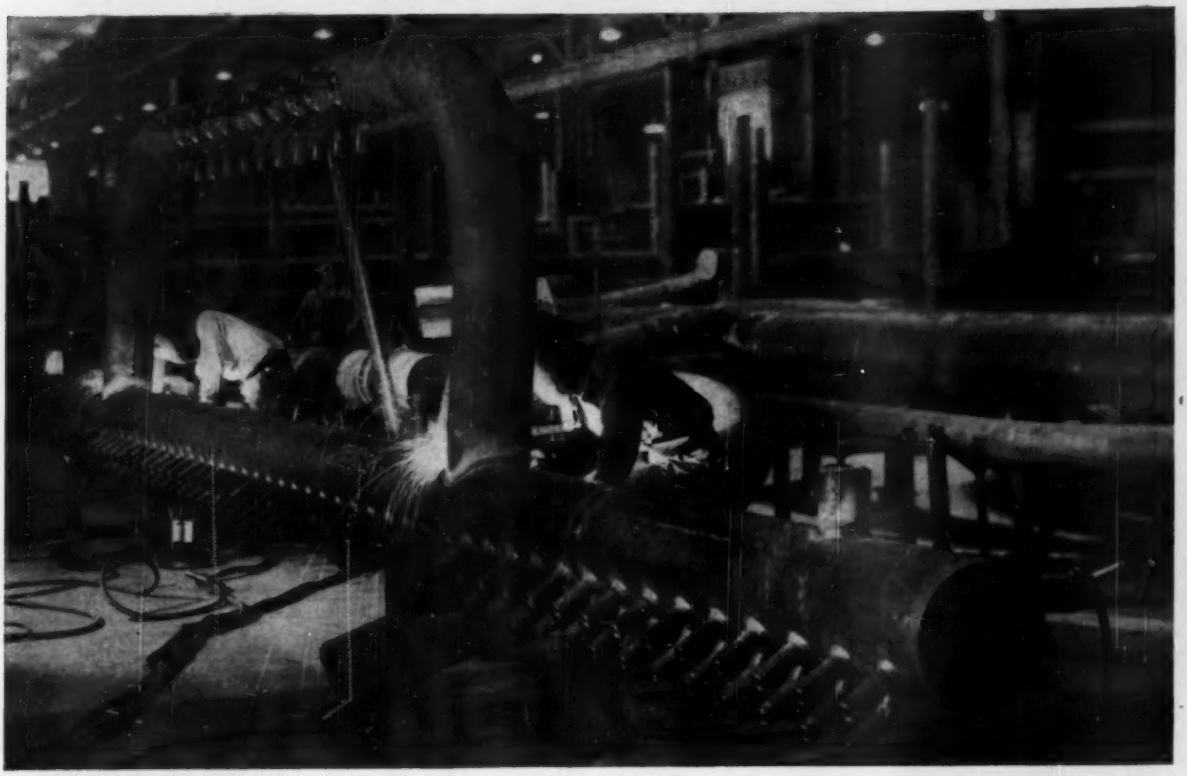
What's Your Diesel I. Q.?
Answers to the diesel engine quiz

For questions, see page 84

1. No. Steam engines are external combustion engines.
2. A. Cylinder walls. B. Piston head. C. Cylinder head.
3. No. Cylinder walls should be smooth, perfectly round and without taper.
4. Connecting rod journal or crankpin journal.
5. Two revolutions, regardless of the number of cylinders.
6. Crankshaft, cylinder head, and push rods.
7. 18...3 per cylinder. One for the injector and two for the valves.
8. Ignition lag.
9. Too much fuel injected.
10. One-half crankshaft speed.
11. Both the intake and exhaust valves are closed.
12. Light haze.
13. 17 times per second.
14. Molecular friction.
15. Btu or British thermal units.
16. Power, exhaust, intake, compression.

cut along this line

EXACTLY as you want it . . .



Bending

Stress-relieving

Ultrasonic Testing

Shop-fabricated piping by Grinnell

With Grinnell shop-fabricated piping — cutting, fitting, welding, and assembly "on location" is reduced to an absolute minimum. That can be important. For when these operations are performed under the less-than-ideal conditions existing in the field, there is always the possibility of less-than-perfect results. For example, errors in cutting or fitting can occur — or welds can contain slight imperfections, which may be difficult to detect and correct with field equipment.

In Grinnell shops, on the other hand, whole sections of complex piping are assembled *exactly* as you want it — with every critical point checked with the latest equipment and by the most modern methods. When these sections arrive on site, they go up fast and *right.*

With Grinnell shop-fabrication too, there are no unforeseen costs. Included in the price (which is determined in advance) are such items of expense as: interpretive engineering, shop sketches and planning, procurement of materials, power services, expendable tools and supplies. There are no charges for waste material.

Consider the quality of the finished job, and final cost. Then consult Grinnell on *your* next piping installation.

To Engineering Societies and Departments: A 30-minute color sound film showing the quality and economy of Grinnell Shop-Fabrication of all classes of piping is available without charge. Contact your local Grinnell Supply Sales Office, or write to Grinnell Company, Inc. 216 West Exchange St., Providence, R. I.

GRINNELL

WHENEVER PIPING IS INVOLVED

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

For more data circle 532 on Post Card

CONSTRUCTION NEWS

Fairbanks, Alaska — Golden Valley Electric Association, this city, is considering plans to install new power lines in its service area. Plans include a 120-mile power distribution line, a 15-mile 69-kv transmission line, and construction of three new substations in connection with these installations. Work on the project will get under way after preliminary engineering work ends and will cost an estimated $2,386,000 when completed in 1961. R. W. Retherford & Associates, Anchorage, Alaska, is consulting engineer.

Lancaster, Calif. — Board of Supervisors, Los Angeles County, 501 Hall of Records Bldg, Los Angeles, has authorized $1,490,000 for the installation of a high-pressure boiler system with auxiliary equipment at Mira Loma Segregation Hospital, located here. Part of the budget will be used to install a refrigeration plant at the local hospital as well. Work will begin at once and is scheduled for completion by late 1961.

Miami, Fla. — Florida Power & Light Co, 25 S. Second St, has announced plans for a major expansion program of its system and generating capacity over the next five-year period and expects to spend more than $485,000,000 for the work. New construction over the period will add 1,430,000 kw of new generating capacity and when completed in 1966, will bring company's total capacity to 3,000,000 kw. Work will begin soon when preliminary engineering work ends.

Lemont, Ill. — Allis-Chalmers Manufacturing Co, 864 S. 70th St, Milwaukee, Wis, has been awarded a multi-million dollar contract to build the power plant for a new atom smasher of the Atomic Energy Commission, now under construction at the Argonne National Laboratory, located here. The 420-ton power supply unit will be part of a 12.5-billion electron volt synchrotron that will be completed in 1962 at a cost of about $29,000,000. The unit, to be furnished by the company, includes a 68-ton steel flywheel, 13 ft in diameter. It will generate 117-million watts every four seconds for delivery to a 4000-ton magnet. Installation will be known as the zero gradient proton-synchrotron and will fire high-energy proton "bullets" at nuclear targets.

Davenport, Iowa — Iowa-Illinois Gas & Electric Co, 205 Perry St, this city, has announced plans for a major addition to its power plant, including installation of additional equipment and improvements in present station facilities. Cost is reported to exceed $750,000. Priester Construction Co, also of this city, has been awarded the construction contract. Work will begin at once and is scheduled for completion by late 1961.

Kansas City, Kans. — Kansas City, Board of Public Utilities, City Hall, is considering plans for expansion and improvement of the municipal power plant, with installation of equipment for increased generating capacity. Work will proceed under direction of Burns & McDonell Engineering Co, project engineers. S. Patti Construction Co, also of this city, has been awarded the construction contract, reportedly about $1,369,000. Additional generating capacity will be placed on line late in 1961.

Louisa, Ky. — Kentucky Power Co, a subsidiary of American Electric Power Co, 30 Church St, New York, N. Y., has authorized plans and will begin construction at once on a large new steam-electric generating station on the Big Sandy River, near this town, located in Lawrence County. Plant will be equipped with a generating unit with an initial capacity of 265,000 kw and will use coal as fuel. It is reported that the new facility will burn about 750,000 tons of coal annually, all of which will be purchased from mines in the east Kentucky area. Work on the plant has begun and is scheduled for completion by the spring of 1963. Cost, with equipment, is reportedly about $39,000,000.

Plaquemine, La. — Dow Chemical Co, Midland, Mich, has announced plans for a major expansion program of its facilities, located here. Included in the program, to cost over $30,000,000, is a new plant for the production of ammonia, increases in production capacity for chlorine, caustic soda, and vinyl chloride. Major expansion and additions to existing power and steam generating facilities are also planned. Work has begun and will take two years to complete. Plant is expected to be in full production by the spring of 1962.

Albuquerque, N. M. — Public Service Co of New Mexico, 424 Central Ave, has announced plans to install a third generating unit at its Reeves Power Station, near here. Utility has awarded contract of $10,600,000 to the Sterns-Rogers Mfg Co, 660 Bannock St, Denver, Colo, for design and construction. Allis-Chalmers Mfg Co, 1126 S 70th St, Milwaukee, Wis, was awarded contract for the turbine-generator. Work will begin at once, and plant will be completed by the spring of 1962.

New York, N. Y. — Consolidated Edison Co of New York, Inc, 16 Irving Pl, and Niagara-Mohawk Power Corp, 300 Erie Blvd, West Syracuse, N. Y., have announced plans for a 220-mile, high-voltage power line network. Work on the $35,000,000 project will begin when design studies are completed. System is slated for completion by July, 1962. Lines will operate at 345,000 v and will have a capacity of about 600,000 kw, providing major economies by quadrupling the power that the two utilities will be able to exchange. Con-Edison's share of the cost will be an estimated $16,000,000, while Niagara-Mohawk's will be about $19,000,000.

Goldsboro, N. C. — Carolina Power & Light Co, 419 Fayetteville, Raleigh, N. C., has authorized plans for a major addition to its plant, located here. Installation of a new steam electric generating unit with an initial capacity of 240,000 kw is planned along with a lake of 600 acres for cooling water for the plant and a dike on the Neuse River to maintain the lake. Work has already begun and is scheduled for completion by the summer of 1962. Ebasco Services, Inc, New York, N. Y., was awarded the contract. Cost will exceed $20,000,000.

Beverly, O. — Ohio Power Co, 301 Cleveland Ave, S. W., Canton, O., has announced contract award to the American Electric Power Service Corp, 720 Second St, S. E., this city, for design and construction of 5000-kw prototype combination steam and gas turbines, at Ohio's Muskingum River Power Plant, located at this city. General Electric Co, Schenectady, N. Y., will supply the steam and gas turbine. Work has begun and installation will be completed by the summer of 1961.

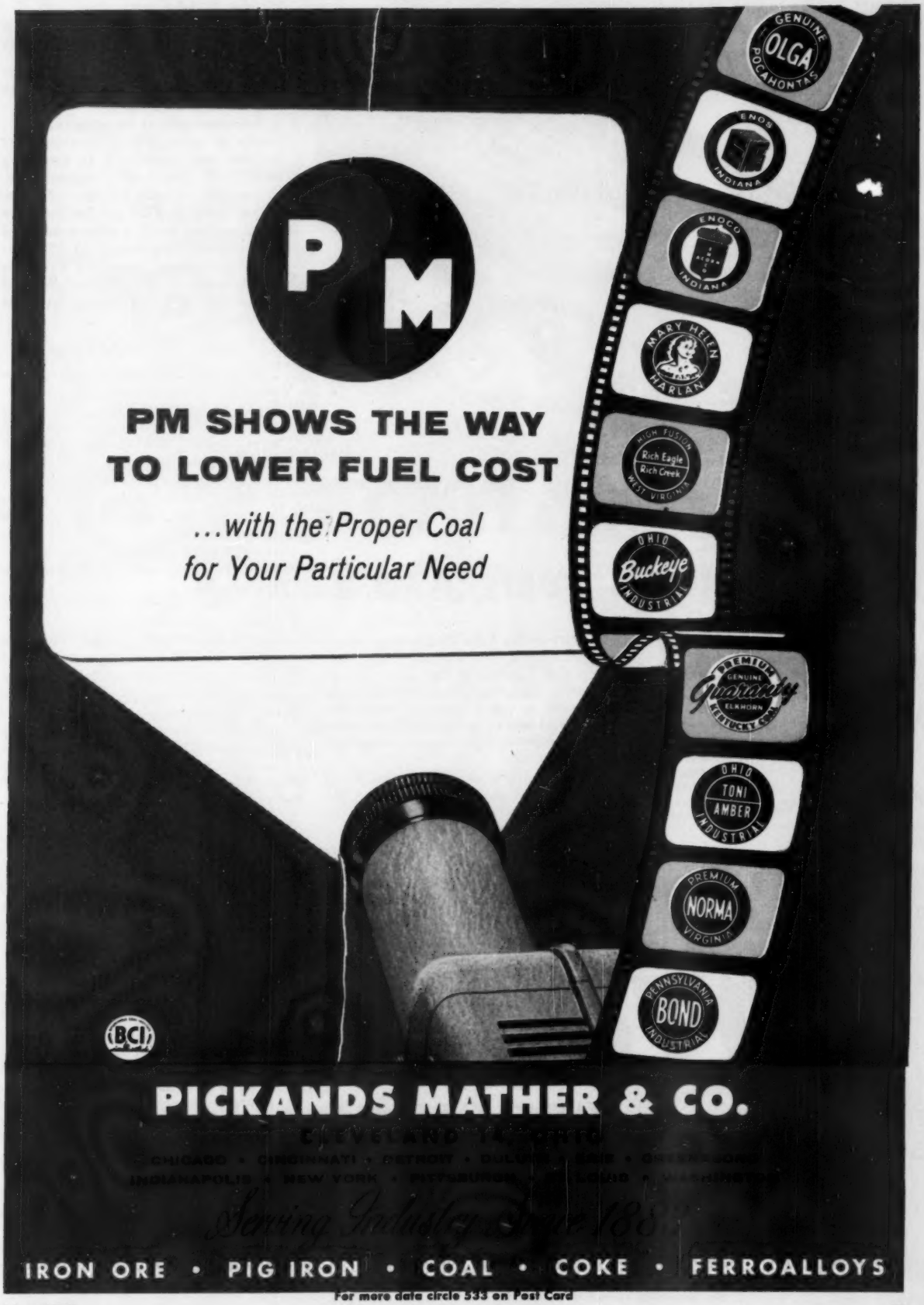
Cleveland, O. — Cleveland Electric Illuminating Co, Illuminating Bldg, this city, has announced a record five-year construction program reported to cost over $190,000,000. Modernization of company's Lake Shore plant is well under way and is scheduled to be completed by mid-1962 with the installation of a 250,000-kw turbine-generator and associated equipment which will cost an estimated $37,000,000. New unit will be the fourth of its size in the company's system and when placed in line, the company's total generating capability will be 2,256,000 kw. Power plant additions continue to be a major construction expenditure for 1960, for which company has budgeted $27,000,000.

Columbus, O. — Department of Light & Power, City Hall, has plans in progress for expansion and improvements in the municipal electric generating station, including installation of equipment for increased output. Cost of additions and improvements is reported to be close to $4,000,000. Work has begun and is scheduled for completion by the winter of 1961.

Allentown, Pa. — Pennsylvania Power & Light Co, Ninth & Hamilton sts, this city, has authorized plans for the expenditure of more than $35,000,000 this year in increased generating capacity and power supply improvements, and a total of $62,000,000 through 1961. Last year company spent $37,000,000 for construction, more than half of which was for a 300,000-kw steam-electric generating station, near Harrisburg, Pa. Utility plans to spend another $14,000,000 this year, to bring this plant to completion by the spring of 1961. Other construction expenditures will include $12,000,000 for power supply improvements and $9,000,000 for new customer connections.

Pearsall, Texas — Medina Electric Coöperative, Hondo, Texas, has announced contract award in the amount of $875,000 to the E. E. Farrow Co, Dallas, for the foundation and structural steel work in connection with the construction of company's new steam-electric generating plant, two miles northeast of this town. Work will include installation of 66,000-kw generating unit, high pressure boilers, and auxiliary equipment. Cost is reportedly about $12,000,000. Douglass & Popham, Chicago, Ill, is consulting engineer.

Washington, D. C. — Atomic Energy Commission, 1901 Constitution Ave, N. W., has announced contract award to the General Nuclear Engineering Corp, Dunedin, Fla, for design of a demonstration nuclear power plant to be erected in Puerto Rico. The cost-plus contract reportedly exceeds $2,000,000. Reactor will be designed to use uranium dioxide for fuel to produce superheated steam that will drive the turbine. The new reactor, when completed, will have an initial capacity of about 16,300 kw.



For more data circle 533 on Post Card

Here's POWER to clean tubes from 1/2" to 2" QUICKLY

Rotojet Junior Tube Cleaners are unusually powerful for their size and weight. They are fed easily through the tubes with the operating hose, and can be shifted quickly from tube to tube. Their convenient size, speed, and ease of operation offer a marked contrast with external cleaners costing many times more.

An air valve directly behind the Rotojet motor permits one-man operation. Very little headroom is required, and either vertical or horizontal tubes can be cleaned.

Simplicity of Rotojet design and precision construction assure long service, efficient use of power, and freedom from trouble. Economical brushes, cutters, and scrapers meet practically any requirement.

Send for Bulletin J-410.

Expanding scraper and replaceable element.

Expanding brush and replaceable element.

Sectional wire brush.

Air valve for one-man operation.

ROTOJET® Junior TUBE CLEANERS

ELLIOTT COMPANY – ROTO PLANT

Tube Cleaner Specialists Since 1910

147 Sussex Avenue, Newark, N. J.

For more data circle 534 on Post Card

MORE ABOUT —

American Power Conference

Continued from page 80

modifications of turbine, boiler, generator, and auxiliaries could be made to yield added capacity.

Another analysis showing the economies of a 22,000-kw peaking gas turbine was given by J. O. Stephens and B. L. Lloyd of Westinghouse. Expansion would be by 220-Mw steam units at $150 per kw for base load, and the peaking plan would add gas turbine blocks of 55-Mw capacity at proper intervals. Present-worth analysis of the plan over 12 years shows a net saving of $1.98 million.

Large Steam Turbines

Real economic considerations justify installation of very large turbine-generator units, said John R. Carlson of Westinghouse, who gave economic analyses of 440-Mw, 600-Mw, and 800Mw units to prove it. For 800-Mw units, with fuel at 25 cents per million Btu, including fixed charges, operating and maintenance, and fuel inventory, total energy cost would be 5.34 mills per kwh, rising to 6.11 mills for a fuel cost of 35 cents per million Btu.

A plant of two 400-Mw units would cost $155 per kw; two 800-Mw units $138.75 per kw. Plants of three 800-Mw units would cost $127.91 per kw; and of four 600-Mw units, $135 per kw. These larger units will be possible because fixed charges are one of the major items of energy cost; also the larger units would be made up of components already proved satisfactory on units of 200- to 300-Mw capacity now in operation.

Reliability of such large turbine-generators, said C. D. Wilson of Allis-Chalmers, depends on many factors. It starts in the design, and requires high-quality materials and manufacturing methods. Coöperation between manufacturer and installation personnel in properly lining up the machine is vital.

In large steam turbines, 300 Mw or larger, it may be possible to design them for additional spinning reserve capacity to meet short-time system peak loads, said J. E. Downs and E. H. Miller of General Electric. Such new, large units for base-load operation are designed liberally to provide low velocities, small pressure drops, and good terminal temperature differences essential to obtaining maximum efficiency.

Turning from large utility units to the smaller ones used in industrial plants, A. J. Klomparens and R. W. Hermanson of Dow Chemical Co described a computer program for

Still ANOTHER Cottrell Advancement By Western Precipitation...

UNIQUE "FULL-RANGE" RAPPER CONTROL PROVIDES ENTIRELY NEW STANDARDS OF VERSATILITY

Rapping Frequency... Rapping Intensity... Rapping Pattern

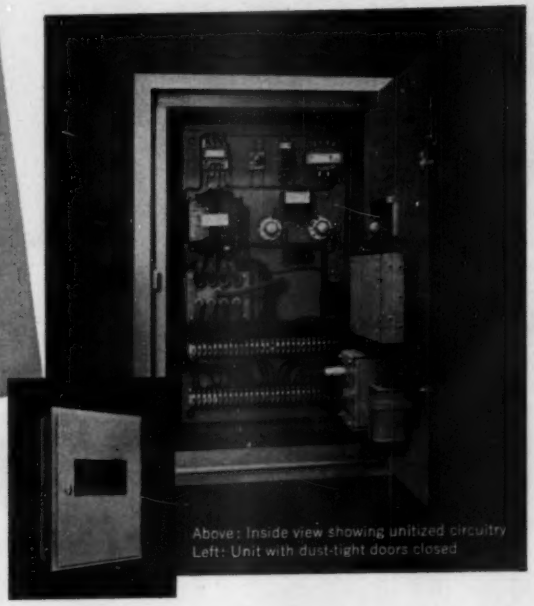
ALL EASILY ADJUSTABLE TO MEET OPERATING REQUIREMENTS

THE PROBLEM:

In the operation of Cottrell Precipitators it is necessary to remove the dust, fume or fly ash that has collected on the plates and cause it to be deposited in a hopper for subsequent removal from the Precipitator. The Rapping System should accomplish this removal with minimum disturbance to the already collected material (to avoid re-entrainment) and with maximum cleaning of the plates.

However, collected materials vary widely in their physical characteristics. Some are sticky. Some agglomerate readily and in thick layers without disrupting electrical operation. Still others have no tendency whatever to agglomerate, but form a sheet of loose particles on the plate.

There is no "typical" dust—no fixed set of conditions to be met. Yet the Rapper System must be readily adaptable to efficient dust removal, regardless of dust characteristics!



Above: Inside view showing unitized circuitry
Left: Unit with dust-tight doors closed

THE SOLUTION:

With so many variables to be compensated, unusually wide adjustability of the Rapper System has long been a prime objective for optimum operating efficiency. But complex factors have prevented its attainment until development of Western Precipitation's new "Full Range" Rapper Control.

By simply adjusting a few dials, "Full Range" Control permits:

- **FULL FREQUENCY ADJUSTMENT** from a complete rapping cycle every 50 seconds to one every 3½ hours... or any desired cycle in between!
- **FULL INTENSITY ADJUSTMENT** from zero to maximum over an unusually wide range!
- **FULL PATTERN ADJUSTMENT** 2, 4 or 8 impacts per cycle can be selected, with each cycle varying from light to heavy on successive impacts within the cycle—all automatically controlled to a choice of pre-selected operating limits!

Other Important Advantages...

Greater Safety: The "Full Range" Control has no dangerous high voltage circuits to endanger personnel. Entire unit is in "low-voltage" category.

All "Passive" Design: There are no motors, gears, or other high maintenance components in the "Full Range" Control. It is completely electronic.

Space-Saving Compactness: The "Full Range" Control requires about *half* the space of previous designs. Also is water and dust tight—can be located virtually anywhere.

Unitized Circuitry: All related parts are unitized into separate "cans" for simplified maintenance.

Free! **NEW BROCHURE** which describes and illustrates the new "Full Range" Rapper Control—the latest product of Western Precipitation's program of continuous advancement!

For quick assistance, call or wire **collect** *our nearest office.*

Only WP has All 6

1. COTTRELL Electrical Precipitators
2. MULTICLONE Mechanical Collectors
3. CMP Combination Units
4. DUALAIRE Jet-Cleaned Filters
5. THERM-O-FLEX Hi-Temp Filters
6. TURBULAIRE-DOYLE Scrubbers

Also: HOLO-FLITE Processors
HI-TURBIANT Heaters

WESTERN
PRECIPITATION
DIVISION OF JOY MANUFACTURING COMPANY

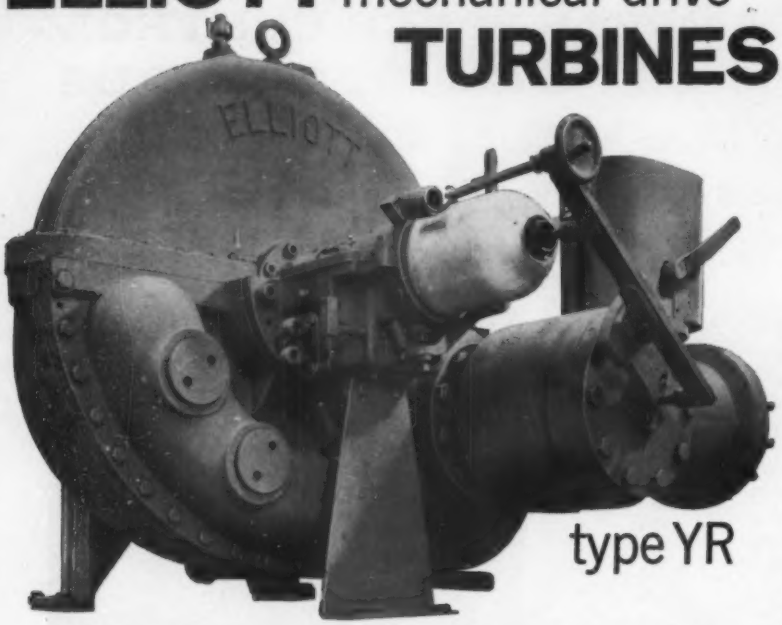
Engineers and Constructors of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries
LOS ANGELES 54 • NEW YORK 17 • CHICAGO 2 • PITTSBURGH 22 • ATLANTA 5 • SAN FRANCISCO 4

Representatives in all principal cities

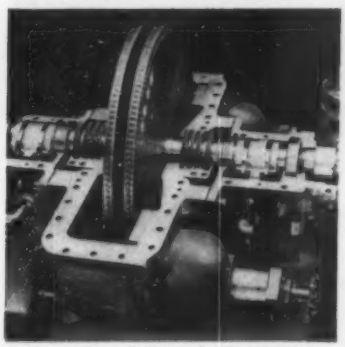
Precipitation Company of Canada Ltd., 8285 Mountain Sights Avenue, Montreal 9

For more data circle 535 on Post Card

ELLIOTT mechanical drive TURBINES

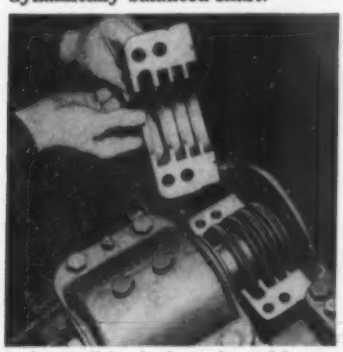


These features mean long life, easy operation



1. Smooth and dependable operation at all operating temperatures is assured by the precise alignment of the dynamically balanced shaft.

2. The governor is direct-acting, simple and weather-proof. Separate trip gives over-speed protection. Easily reset against line pressure.



3. Accessible shaft-seals and bearings simplify maintenance and inspection. Covers are readily removable without disturbing the casing.

4. Economy at partial loads is secured by the steam-saving hand valve with pilot, which can be opened against full steam pressure.

ELLIOTT Company
JEANNETTE, PENNA.

HO-2

For more data circle 536 on Post Card

evaluating industrial turbine performance. The company, at its Midland division, has 12 turbine generators ranging from 4000 kw to 37,500 kw in capacity.

Periodically, a routine test is performed on each unit. Test calculations done manually on a desk calculator required from 16 to 120 manhours. Now, the same calculations, performed on a Burroughs 204 digital computer, take approximately 3 to 20 min.

Fundamentals of Fuel Oil Combustion were discussed by D. S. Frank of the Pure Oil Co. After describing viscosity and temperature characteristics of No. 6 fuel oil, he then gave data on the way oil burns and on final preparation of it for burning.

Pressure-fired spreader-stoker boiler and other novel features of an industrial power plant were described in detail by H. H. Reisman of Deere & Co. Details of the stoker and boiler were presented in the April, 1960, issue of POWER ENGINEERING.

LeRoy F. Deming of the Bureau of Yards & Docks, U. S. Navy Dept, described briefly the Bureau's experience with field-erected boilers that motivated its action toward factory fabrication.

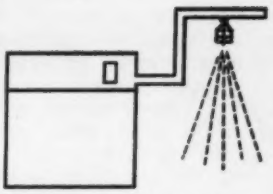
Use of probes containing radioactive material, for measuring density and moisture in large coal storage piles, was discussed by A. S. Grimes of American Electric Power Service Co, with co-authors B. B. Bonadio of Indiana-Kentucky Electric Co, and H. I. Lamphier of Ohio Valley Electric Co.

At Hawthorne Station of Western Electric Co in Chicago, a fourth boiler unit has recently been added to three existing boilers. This fourth unit is a 150,000-lb-per-hr Riley Turbo-Furnace design, equipped with a wet bottom, or slag-tap furnace. The other three units are dry bottom.

This unit was installed to provide a way of discharging its own fly ash as slag, and also to receive fly ash from the other dry bottom furnaces, fuse it into slag, and then discharge it. The new unit has fulfilled these requirements at a 2-per-cent higher efficiency than the existing units.

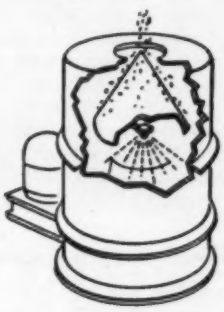
Details of the furnace, the methods of collecting fly ash, test data, and other factors are given in the paper by H. M. Rayner of Western Electric and L. P. Copian of Riley. The performance tests show the unit can slag all its own fly ash, and fly ash from two other dry-bottom-boilers, with no appreciable increase in dust loading.

Combustion safeguard interlock systems for multiple-burner boilers

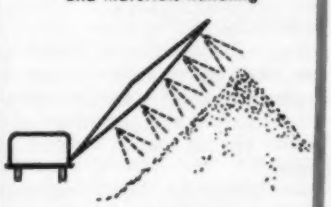


J-M Chem-Jet—
Engineered systems that control dust at its source

J-M Hydro Voluet Scrubbers—guaranteed 99% efficient in removing dust, fumes, odors

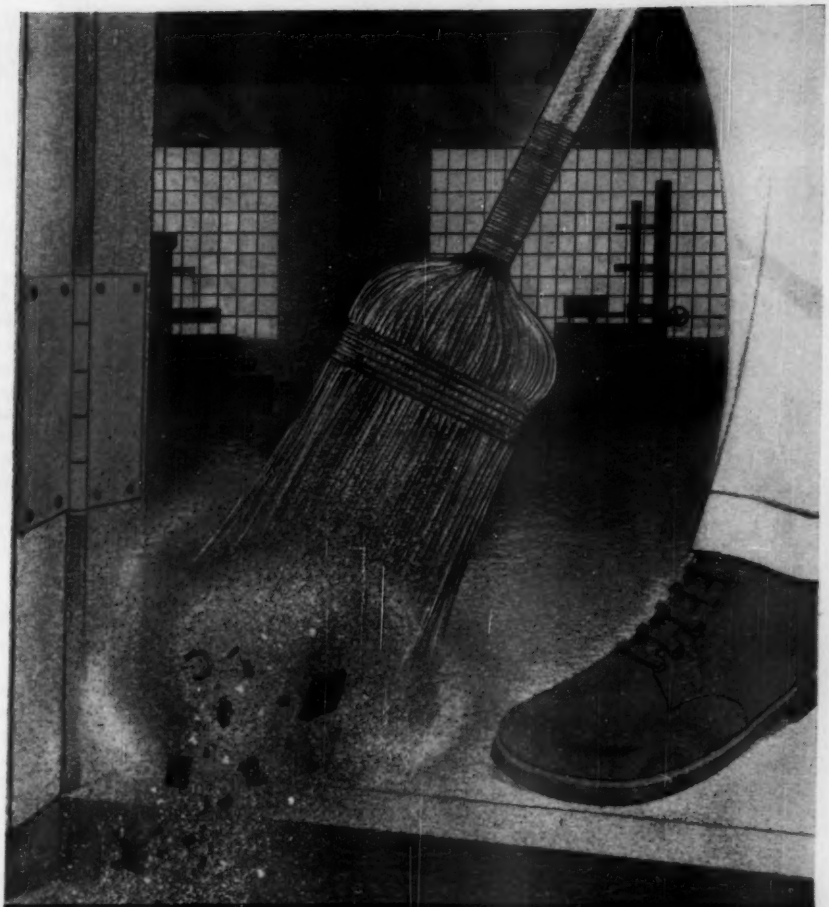


J-M Verticone—
for dust-free unloading and materials handling



J-M Compound S-P—
prevents costly windage loss of materials stockpiled outdoors

new low prices on J-M equipment



You can't sweep away serious dust problems

Any dust problem makes efficient housekeeping impossible; increases your overhead; makes for premature obsolescence of equipment; reduces morale of personnel . . .

For years Johnson-March has specialized in engineered answers to dust problems. By developing new techniques J-M makes possible low cost dust control for all plants.

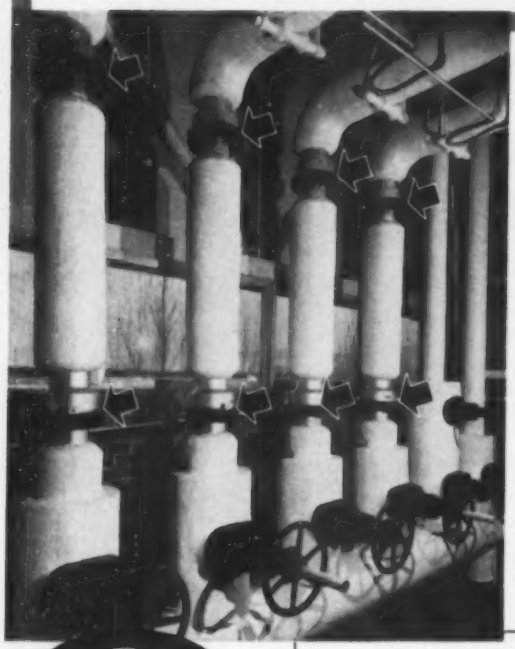
Take the first step by arranging for an on-the-spot analysis by a Johnson-March engineer. Ask your consulting engineer or write to Johnson-March Corporation, 3018 Market Street, Philadelphia 4, Pa.

JOHNSON MARCH

dust control engineers

For more data circle 537 on Post Card

Barco Solves Boiler Piping Expansion Problem



Relieves Strain on Valves

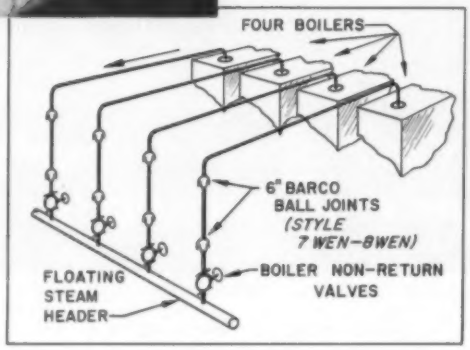
This photograph shows an interesting new installation of eight Barco Flexible Ball Joints (see arrows) on four 250 psi boiler steam lines in a West Coast industrial plant. The schematic diagram (below) shows the piping layout.

Due to the fact that operation of individual boilers is intermittent, complicated expansion, contraction, and torsional movements occur in the piping. All of these movements are easily accommodated with the aid of the Barco Joints, relieving reactive forces on the non-return valves.

BARCO

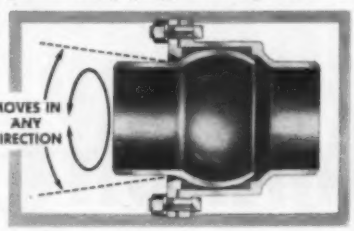
BALL JOINTS

1. Handle Expansion
2. Relieve Torsion



PROBLEM—Originally, in the plant shown above, it was thought that the "spring" in the long runs of piping would take care of *thermal expansion* and *torsional stresses*. SUCH WAS NOT THE CASE. Serious trouble was encountered, tending to crack valve flanges and twisting so they would not seat tight.

ANSWER—Barco Ball Joints solved the problem, LOGICALLY, SIMPLY, ECONOMICALLY. These rugged all-steel joints have no thin wall sections, no critical points of fatigue, no rubber seals. They are practically indestructible. They provide points of flexibility in piping. Easy to engineer. They fit right in the piping; develop no "end thrust"; require no expensive anchoring. Sizes and styles to meet your requirements. *Send for catalog and information.*



BARCO MANUFACTURING CO.
547F Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

For more data circle 538 on Post Card

were described by R. E. Kittoe of Electronics Corp of America. After discussing causes of boiler furnace fuel explosions, the author details the recommendations for safe operation. He detailed a safety interlock system for lighting-off and relighting, because incorrect procedures here were by far the largest single causes of explosions.

A power plant safety program, as carried out at State Line Station of Commonwealth Edison Co, was explained by W. C. Kramer, assistant superintendent of the station.

Steam-pneumatic ash-handling equipment for industrial power plants was discussed by A. M. Perrin of National Conveyors Co.

He pointed out that ash conveyor fittings — including elbows and laterals — represent 8 per cent of total material cost, and no compromise on their quality should be made, because they receive more wear than any of the other components. He discussed types of piping used, storage bins, and unloading equipment.

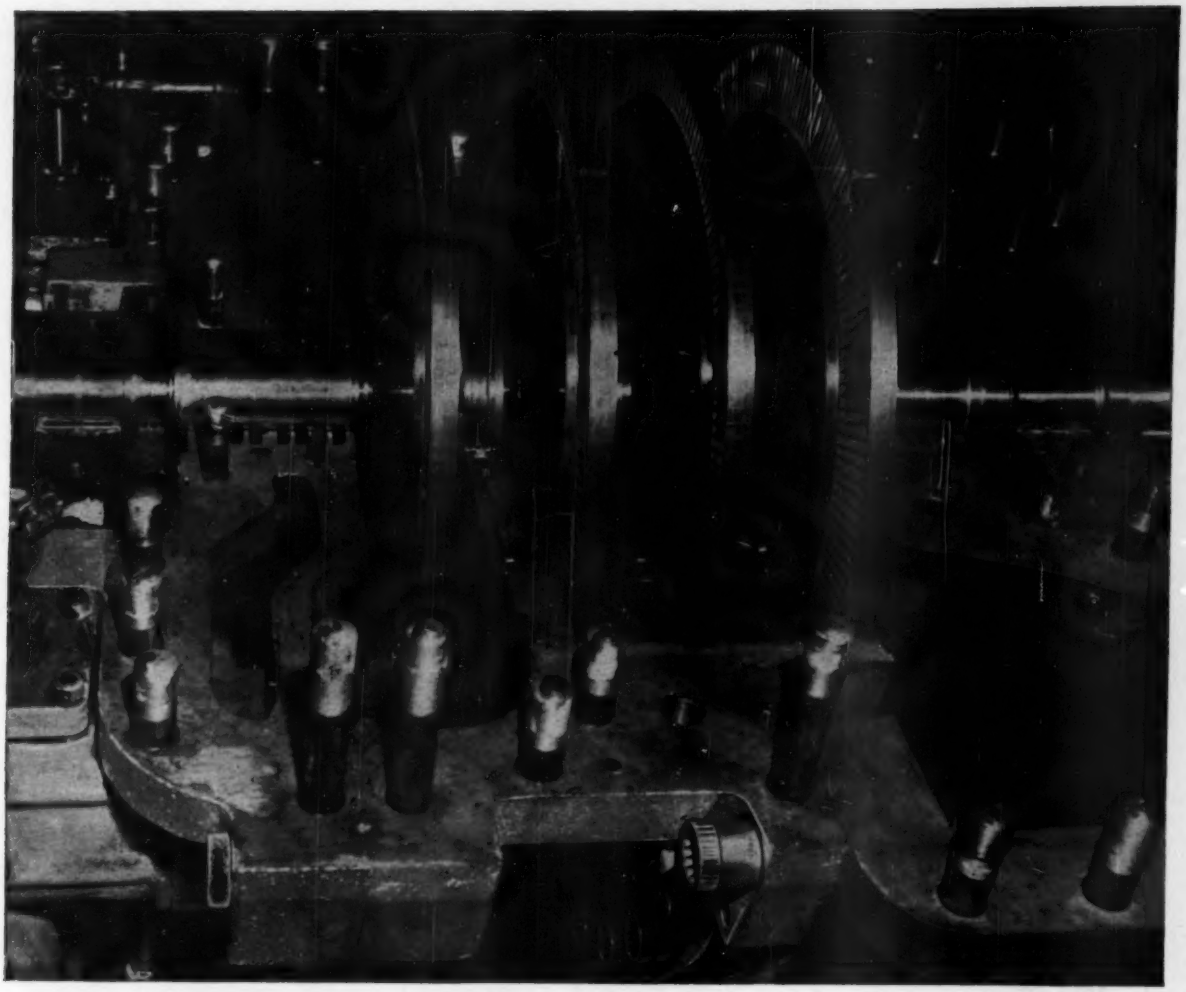
Methods of predicting tube life on large high-temperature steam generators were explained by J. L. Menson, W. L. Harding, and E. P. Petit of Combustion Engineering. These are based on relations between tube wastage, temperature, metal stress, and so on. Object of the method is to predict life before rupture of tubes, in which some reduction of wall-thickness by wastage has been measured. Equations and curves are presented, and the method has been proved in a number of cases.

Control and Interlocking

Taking large gas-fired steam-boiler turbine generator units as examples, L. Skog, Jr. and E. H. Finch of Sargent & Lundy analyzed control and interlocking for them. They said that the most important differences between control systems (that are still unresolved) are: a, boiler ignition and burner protective systems; b, interrelation of boiler-turbine generator interlocks; c, protection of the system against loss of a boiler feed pump.

On point a, they diagrammed and explained the controls and interlocks required. On point b, they showed how the protection of the electrical end of the unit can be coordinated with that of turbine and boiler, for on large systems, shutdown of a unit in case of trouble is less serious than formerly. On point c, controls should trip the entire unit off the line automatically, some engineers feel, if a half-capacity boiler feed pump should fail.

Ways of using the low-level econo-



THE INSIDE STORY OF A MURRAY HIGH SPEED COMPRESSOR

DRIVE TURBINE REVEALS THE REASONS FOR MURRAY'S UNIVERSAL ACCEPTANCE

A look at MURRAY'S rugged construction from the inside shows the husky shaft and heavy accurately formed discs with generous sized hubs designed to withstand the axial and radial stresses imposed by this type of service.

Large-dimension disc rims receive the specially contoured stainless steel blades with the Murray integral shroud. This insures smooth steam passages with maximum strength.

Short bearing spans insure smooth operation and eliminate the hazard of operating in critical speeds.

A look at the heavy flanges and husky bolting in the actual unretouched shop photo shown above bears out the extreme ruggedness that typifies every feature of Murray construction.

Our nearest representative will gladly help you solve your high speed compressor drive turbine requirements. Just write to Murray Iron Works Company, Burlington, Iowa, for his name.

Murray
TURBINES

MURRAY IRON WORKS COMPANY • BURLINGTON, IOWA

Builders of Steam Power Equipment for Nearly a Century

For more data circle 539 on Post Card

NEW TYPES

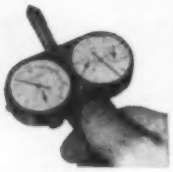
IMPROVED MODELS

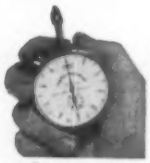
COMPLETE LINE

Instantaneous speeds—variations in speeds—average measuring in RPM or FPM—the newest model instruments are described in this new Biddle Bulletin. Handy Selection Chart gives name, range, description and accuracy of all the tachometers in the Biddle line—resonant reed—centrifugal—chronometric—hand and fixed types. Request your copy today.

Check Speeds Accurately

POWER TRANSMISSION
LUBRICATION
SLIPPAGE
FRICTION
STRESSES
LOAD
ETC.



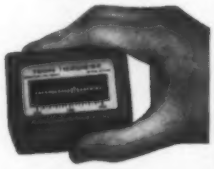


JAGABI® TACHOSCOPE
A Speed Counter and Stop Watch in one

JAGABI® SPEED INDICATOR
Speeds Up to 100,000 RPM

JAGABI® TACHOMETER
Speeds Up to 48,000 RPM
Single or Multiple Ranges

FRAHM®



METRON TACHOMETER
Activated by flashlight cell. Selection of ranges and scales to 100,000 rpm or 10,000 fpm.

RESONANT REED TACHOMETER
No contact with moving parts—just touch to case of machine or motor housing—read directly in rpm.

WRITE FOR BULLETIN 35-PE

B-903

JAMES G. BIDDLE CO.
Electrical Testing Instruments • Speed Measuring Instruments
Laboratory & Scientific Equipment
1316 ARCH STREET, PHILADELPHIA 7, PA.

For more data circle 540 on Post Card

mizer were reviewed by J. H. Potter of Stevens Institute of Technology.

Operating experience with low-level economizer installations is still fragmentary; but several utilities have installed them, a small industrial installation employs them, and heat-rate improvement is found in plants with high-sulfur fuel where the low-level economizer supplies air tempering energy.

High-Voltage Transmission

High-voltage transmission came into the limelight in a number of excellent papers this year. Considering technical and economical aspects of this subject, a paper by Messrs. Breuer, Simmons, and Woodrow of General Electric had this to say:

The need for EHV transmission lines in the United States has been created by the increasing extent of power pools, and larger turbine generators — this as opposed to sending large blocks of power over extremely long distances. Congestion in industrial areas, and reliability of service, will be the prevailing criteria in the United States.

In summary, the authors stated that 345-kv transmission can be justified at 50 miles; also much higher voltage appears attractive for distances of 200 miles or more. Further, the relatively high cost of d-c transmission terminal equipment makes it unattractive for overhead transmission in the United States.

Product developments have made the intermediate voltages, 115 through 161 kv, much more suitable for short-distance, high-power transmission.

C. R. Bond of Ohio Edison and F. A. Denbrock of Commonwealth Associates presented some very interesting material on the design and test of 345-kv transmission lines. Studies were made on conductors and towers of 345-kv lines; the narrow-base tower was considered to be of primary interest in this study.

Many combinations of conductors were compared; also, radio influence characteristic comparisons were made, based on ratios of critical corona voltage to maximum operating voltage.

This paper included most of the design concepts. The conclusions drawn from all of the studies indicated that bundled conductors should be 954 mcm-48/7 ACSR. Also, a spacing between conductors of 18 inches was selected. It was concluded that an 18-unit string of insulators would be most satisfactory. The final tower design selected was an all steel, narrow base, waist-type structure.

Public Service Co of Colorado has

conducted a most interesting research project on EHV lines through the Rocky Mountain area. For design criteria, an average altitude of 10,500 ft was selected. The paper presented at the Conference was written by L. M. Robertson of Public Service Co of Colorado, and J. E. O'Neil of Westinghouse.

In this research project all of the factors involved in high-altitude winter weather were included. Several types of structures were considered, and both steel and wood were evaluated. Since wood poles, in the sizes needed for EHV transmission, are scarce and expensive, tubular metal towers are becoming more attractive. Also, since the company's record of lightning performance on 115-kv lines using wood crossarms had been excellent, it was decided to use wood arms in the test fixtures.

Data have been obtained from the test line for the past three years. Most all of the factors which would be experienced on an actual line have been evaluated, in addition to the electrical characteristics of the line. The maintenance problems also have been evaluated. In the area served by this power company, the terrain and altitude make it difficult and expensive to maintain the transmission lines.

While the final test data have not been completely published, it is believed that they will be, in the not too distant future. A number of manufacturers have participated in the project. These include: Westinghouse, American Bridge, Hughes Brothers, Malleable Fittings, Ohio Brass, and Alcoa.

Eddystone Station Transmission

Construction of the 650-Mw Eddystone station presented some unusual problems of transmission design, and the background in this study was presented very nicely in a paper by E. B. Shew and A. H. Sellers, both of Philadelphia Electric.

Because of the congestion in the general area, and some unusual right-of-way problems, the lines received an unusual amount of consideration. Voltage selected for the major portion of the project was 132 kv. Joint construction along the Pennsylvania Railroad right-of-way made this construction practical. Conductor size selected for use at all voltages was 795 mcm ACSR.

This project increased the company's transmission system 20 per cent by the addition of 104 miles of lines. Of this total, 82 miles were designed for 132 kv, and 22 miles at 220 kv.

To make the project even more

that's what you want in a fuel...

what you get in B&O Bituminous!

Sure, bituminous coal is power-packed—it's prepared to suit any industrial utilization—its source is most convenient to industry. But, bituminous gives you the *extra* that no other fuel can—*nearly inexhaustible reserves, always available!*

B&O BITUMINOUS COALS FOR EVERY PURPOSE

Ask our man! BALTIMORE & OHIO RAILROAD

BALTIMORE 1, MD., Phone: LExington 9-0400

For more data circle 541 on Post Card

ANALYZE for water hardness ...phosphates...residual chlorine AUTOMATICALLY ...ECONOMICALLY

Surprisingly simple, compact, and economical, new Chemalyzer* instruments automatically perform complete colorimetric analyses and accurately indicate results in ppm ranges . . . . even sound the alarm when pre-set limits are exceeded.

Chemalyzer instruments eliminate the wasteful and ineffective practice of limiting the capacity of the system in order to maintain proper control. With Chemalyzers on the job there's less frequent regeneration . . . less money spent on labor and chemicals. And you get a more dependable, full-capacity system.

The completely self-contained unit is easily installed and put to work in a matter of minutes. Few moving parts and rugged construction insure a long time on the toughest jobs without service problems. Typical analyses include water hardness, phosphates, residual chlorine, and other single reagent analyses.

GET FACTS ON Chemalyzer analyzers in Bulletin 858-1. Write Milton Roy Company, 1300 Mermaid Lane, Philadelphia 18, Pa.

*Tradename

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

For more data circle 542 on Post Card

complicated, a river-crossing over the Delaware River was involved. Submarine cable was considered, but discarded for a number of reasons. Also, a conventional overhead crossing involved many restrictions, because of regulations imposed by the Army Engineers and the Federal Aviation Agency.

The final design of the river crossing involved 3 spans; the main one was 2754 feet, and the two anchor spans were 1700 and 1100 ft. Also included in the transmission project is 13 miles of underground cable.

EHV Lightning Performance

Advent of some of the new high-voltage lines constructed in recent years has created some problems of lightning protection, which were not experienced in the lower-voltage lines. Although a number of engineers have been investigating this problem, a paper given by C. H. Wagner and A. R. Hileman, of Westinghouse, expresses their theories on this new phenomenon.

After extensive investigation, these authors believe that the voltage across the string of insulators on a transmission line tower (struck by lightning) can be resolved into two components. One of these is due to the current fed into the system from the lightning stroke. The other component is that created by the changing charge in the stroke above the tower.

In conclusion, these two authors feel that the effect of the charge above the tower offers the most reasonable explanation of the high outage rates presently being experienced on some EHV lines.

Increased use of air conditioning and automation is creating a demand for higher distribution voltage in industrial plants. According to J. D. Wood and F. Tamberrino of I-T-E Circuit Breaker Co, larger blocks of power are required in decentralized locations scattered throughout the plants. To serve this increased load, it is usually more economical to go to higher voltages — with decreased cable sizes.

Actual selection of the distribution voltage will depend on type of load, total loads at these decentralized locations, distance of loads from power supply, and voltage available from the power company. Of course, if the industrial plant has its own power plant, the last factor would apply, also.

Until recently, in most cases, metal-clad switchgear with air circuit-breakers was the only type considered. Recent developments in fused interrupter switches have prompted their use more frequently.

If they can be used, the owner will get a more economical installation.

In cases where high available short-circuit current necessitates use of a circuit-breaker (with a maximum continuous rating far in excess of load requirements), the authors suggest use of a combined circuit-breaker and current-limiting fuse.

Hydroelectric

Sessions on hydroelectric power this year concentrated on financial problems. George P. Steinmetz, chief engineer of the Public Service Commission of Wisconsin, opened the discussion with a description of how a utility regulatory commission functions.

Financial aspects of electric power in Puerto Rico were sketched by S. L. Descartes, Victor M. Cataldo, and Antonio E. Lebron of the Puerto Rico Water Resources Authority and by Henry W. Hills and Edmond R. Foster of Jackson & Moreland, Boston. In 1945 revenues from the sale of electric power in the island were $5,589,760. By 1959, this figure had increased to $35,800,000. At present the Authority is serving 398,530 customers.

Colin W. Raff of the Montana Power Co, in discussing the financial problems of investor-owned hydro utilities, called attention to the fact that the trend in rate of return for investor-owned utilities has been slipping during the past 14 years, despite the phenomenal growth in the industry. Rate of return has dropped from 7.1 per cent in 1946 to 5.7 per cent in 1958.

For a group of six major Pacific Northwest systems, 87½ per cent of whose generating capacity is in hydro plants, rate of return in 1958 averaged only 5.5. per cent. Reflected in this is the fact that it requires five or six years to plan and build major hydro projects, while thermal plants can be built in far less time. Add to this the greater capital investment in hydro facilities and the result is obviously a larger investment spread over a longer period of construction with greater impact on the utility's income statement.

How financing plans are developed for a large utility was the subject presented by George H. Pritchard of Commonwealth Edison Co, which has been carrying out huge construction programs costing $1.5 billion for electric property additions and revisions.

Details of financing the St. Lawrence Project were presented by Leslie N. McClellan of the Power Authority of the State of New York. When all of the power contractors take and pay for their full contract

DEKORON ARMORED INSTRUMENT HARNESS

4 + 4 = 16

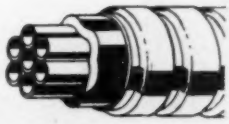
TUBE MATERIALS + TUBE CONSTRUCTIONS = DIFFERENT TYPES

Yes, *four* different core tubing materials (copper, aluminum, polyethylene, nylon) combined with *four* distinct types of armoring give you *sixteen* different types of Dekoron Armored Instrument Harness from which to choose.

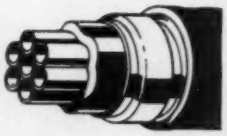
Designed specifically for instrument harness application, special Moore-Loc armor construction has almost twice the pull-apart resistance of ordinary armoring . . . has cord packing for extra resistance to moisture and fume penetration.

There's at least one best type of Dekoron for your installation. We help *you* select it; we're unbiased because we make all types. Now go Dekoron 100% for all your tubing needs. Think of Dekoron first . . . to last. That's *Dekoron—America's Premier Line of Armored Instrument Harness.* A-583A

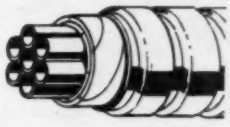
CONSTRUCTIONS

TYPE VA 

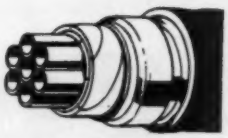
For Impact and Corrosion Resistance. Core tubes with vinyl sheath covered with Moore-Loc modified-square-lock construction armor with cord packing.

TYPE VAV 

For Impact and Maximum Corrosion Resistance. Same construction as Type VA (*above*) but with outer vinyl sheath. 24-gauge galvanized steel armor gives maximum pull-apart and impact resistance.

TYPE A 

For Impact Resistance in Dry Locations. Core tubes are wrapped in vinyl-impregnated insulating tape. Tape insulates and cushions core tubes inside metal armor.

TYPE AV 

For Corrosion and Impact Resistance. Same construction as Type A (*above*) but with outer vinyl sheath. All four constructions available with metal or plastic core tubes.

Dekoron® products QUALITY • RESEARCH • SERVICE

SAMUEL MOORE & COMPANY

DEKORON PRODUCTS DIVISION • MANTUA, OHIO

For more data circle 543 on Post Card

Efficiency of heat exchangers starts with AIRETOOL here

A complete line of efficient, powerful pneumatic tube cutters, cleaners and expanders.

AIRETROL

Compact, fast, efficient, easy to operate. Air-powered tube rolling up to twelve ¼" to 1½" OD tubes per minute. Precision pneumatic control stops expansion automatically within .001" of predetermined setting.

and here

Model CC-475 Lightweight condenser cleaner with air driven motor. Easy, one-man operation with no rig. Hard deposits and completely plugged tubes quickly and efficiently reamed out. Built-in flushing system washes cuttings away and cools the drill.

For complete information on Airetool pneumatic equipment for fabrication and maintenance of heat exchanger tubes, write today.

30 years experience in pneumatic tools

Branch Offices: New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge **Representatives** in principal cities of U.S.A., Canada, Mexico, South America, England, Europe, Puerto Rico, Italy, Japan, Hawaii **European Plant:** Vlaardingen, The Netherlands **Canadian Plant:** Brantford, Ontario

For more data circle 544 on Post Card

commitments, it is estimated that the gross revenues from power from this project will amount to $27,112,000, or slightly more than the maximum bond service requirement of $26,671,000 which will occur in 1965.

Generator Cooling

Three excellent papers were given on this subject, each covering a different technique. L. M. Abrahamson and L. T. Rosenberg of Allis-Chalmers cited the fine operating record of generators with conductor-cooled rotors and stators. Since 1954, some 2,000,000 kva of such machines have been placed into service. In this design, the cooling ducts are actually inside the conductors, hence the name.

With a single cooling medium, hydrogen, the authors feel that conductor-cooled generators will be built in ever-larger sizes.

Another type of cooling, called Inner-Cooling, was reported on by Owen K. Brown of Niagara Mohawk and J. W. Batchelor of Westinghouse. This system is similar in principle to conductor-cooling; however, the cooling ducts are within the ground wall of insulation, rather than in the individual conductor.

Operating experience on inner-cooled generators has been excellent, also, and over 23,000,000 kva of capacity have been built — or are on order.

Third type of cooling was discussed by C. E. Kilbourne and C. H. Holley of General Electric. This system uses liquid, rather than gas, as the cooling medium. The liquid is transil oil, and is applied to stator windings. The authors feel that this system will continue to grow in popularity, and that units of 700,000 Mw will soon emerge from the design stage.

Water Technology

This field of interest was covered from three approaches: water management in industry, advances in evaporation techniques, and control and automatic analysis.

J. D. Frame of Cities Service Research and Development Co described the $3,000,000 waste control facility installed for the company's Trafalgar refinery in Ontario, Canada. Required by the Ontario Water Resources Commission to reduce phenols in the refinery effluent to not more than 15 ppb before discharge to nearby Lake Ontario, the company decided to make the most of the pollution control operation and with it stimulate public interest and good will.

Built as an annex to the waste treatment plant is an aquarium in which game fish of the region are

maintained in effluent from the refinery. Also, on the lakefront at the plant's pumping station location, the company built a small park complete with an illuminated fountain fed by effluent. A program was undertaken to encourage the public to visit both refinery-aquarium and fountain, and about 67,000 people visited during the five months' summer period of last year.

Gordon F. Leitner of Cleaver-Brooks Special Products presented a paper on latest developments in seawater conversion as a by-product of power generation. (See POWER ENGINEERING, March, 1960, page 82.) Leitner stated that in his company's experience, converted water costs of 70 cents to $1 per 1000 gallons are attainable with presently available proved equipment.

Flash evaporators for the utility industry were discussed by R. L. Coit of Westinghouse. He reported that a single-stage flash evaporator incorporated into the regenerative cycle below the lowest pressure heater results in a substantial reduction in heat rate when compared with a submerged-tube unit located above the deaerator. (See the article in this issue, page 60).

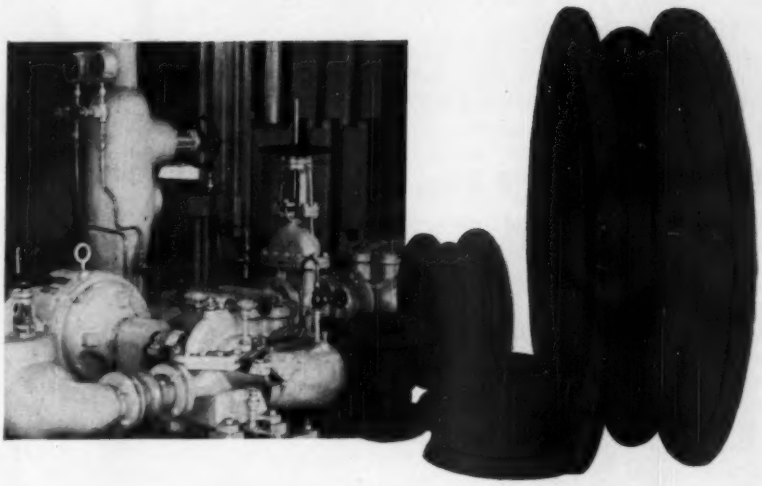
J. A. Levendusky of Graver Water Conditioning Co and F. N. Megahan of Philadelphia Electric Co described the coöperative studies carried out by the two companies to develop analytical procedures for determining trace impurities in condensate at the new Eddystone Station. This station, with a maximum design pressure of 5000 psig and temperatures of 1200 F, requires ultra-pure water, with contaminants measured not in ppm but in ppb. The studies have produced satisfactory analytical procedures having sensitivities and accuracies of 1-2 ppb for determining iron, copper, chromium, nickel and silica. There is, however, still a considerable amount of work to be done on the zinc and aluminum method.

Results obtained with the zero solids method (ammonia-hydrazine) of water treatment for high-pressure boilers have been most gratifying, reported R. I. Smith of Public Service Electric and Gas Co.

Robert T. Sheen and Earl J. Serfass of the Milton Roy Co stressed the importance of reliable instrumentation to monitor the concentration of contaminants in modern boiler-turbine systems. Recognizing that we are now faced with the problem of restricting contamination to parts per billion levels if we are to realize maximum efficiencies and prevent outages that may cost in excess of $15,000 a day, these experts de-

Turn to page 103

Save... ON INSTALLATION AND REPLACEMENT COSTS *With* GOODALL *Rubber* EXPANSION JOINTS



Goodall Rubber Expansion Joints are flexible, durable connections for pipe lines and other equipment handling virtually all fluids and gases under pressure and vacuum, to prevent excess stresses due to expansion and contraction; to counteract vibration; and to insulate against undesirable sound. They can also be designed to overcome misalignment.

EASIER TO INSTALL—on new equipment or as replacements. Light in weight, with short face-to-face dimensions. Metal retaining rings quickly aligned and bolted. No gaskets required.

LONGER SERVICE LIFE—no embrittlement or corrosion. High resistance to abrasive wear.

STYLES, SIZES AND PRESSURES TO MEET ALL REQUIREMENTS

Contact Our Nearest Branch, or Write for Catalog

"If it's GOODALL, it MUST be Good!"

Standard of Quality—Since 1870

HOSE · BELTING · FOOTWEAR · CLOTHING AND OTHER INDUSTRIAL RUBBER PRODUCTS

GOODALL *Rubber Company*

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

BRANCHES AND DISTRIBUTORS THROUGHOUT THE UNITED STATES. IN CANADA: GOODALL RUBBER CO. OF CANADA LTD., TORONTO.

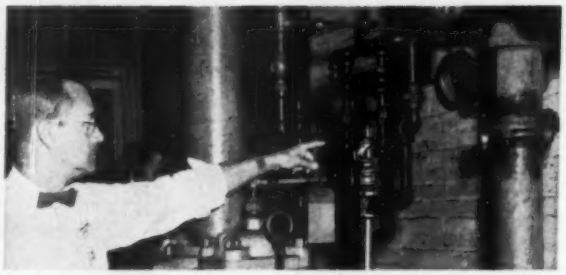
For more data circle 545 on Post Card

SARCO TOPICS

How to save water and prevent over-cooling of compressors, small engines, and hydraulic oil-coolers

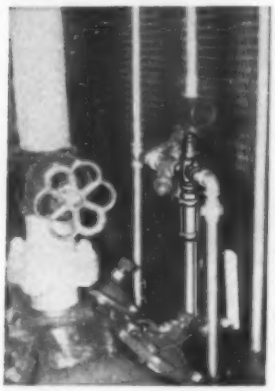
When cooling water is controlled manually the operator frequently leaves the valve nearly wide open, in order to play safe if the load varies. The result is over-cooling. If he attempts to vary the flow of water he risks the danger of under-cooling. Automatic cooling controls assure proper cooling at *all* times and effect important economies in water consumption.

And here are three different experiences at Revere Copper and Brass plants which may give you some tips on solving your own cooling control problems.



T-44 cooling control on compressor at Rome Manufacturing Co. Div. of Revere. Sarco sales representative Emile Strickland points to control installations.

How Revere Copper & Brass Saved over 50% on water



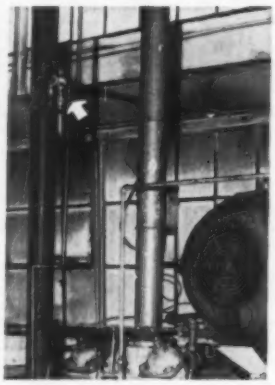
Sarco T-44 automatic cooling control installed at Revere's Riverside plant.

The Riverside, California, plant of Revere Copper & Brass was plagued by over-cooling of compressors. In addition, their water consumption was high — approximately 2,000 gallons an hour. By simply installing Sarco T-44 automatic cooling controls on the compressor cooling lines, plant engineers eliminated over-cooling and cut water consumption about 60%.

Another benefit was a saving in tool maintenance. (Originally excess moisture was causing difficulty with a large number of air screwdrivers used in the plant.) With the T-44's in service the maintenance problem has practically disappeared.

Manual control was wasting water at Rome Manufacturing Co. Div., Rome, N. Y.

At the Rome Manufacturing Company Division of Revere, at Rome, N. Y., cooling water for air compressors originally was manually controlled. When they installed Sarco T-44 automatic cooling controls on the cooling water lines they made substantial savings in water. They saved damage and maintenance cost on the compressors, too. That's because they eliminated the errors inherent in manual control. Automatic cooling controls always assure optimum cooling by permitting safe operation at the maximum temperature recommended for any given machine or process.



Installation of a Sarco T-44 on compressor at Rome, N. Y.

Water conservation program at Baltimore led to automatic control

Double target of engineers at the Baltimore plant of Revere was a water conservation program plus tighter temperature control. To achieve both objectives they installed Sarco automatic cooling controls on an air compressor, an aftercooler and a hydraulic oil cooler.

Results were so satisfactory they followed through by installing 50 additional Sarco controls.

For more information on cooling control, contact your Sarco Sales Representative, District office, or write — 2169

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

For more data circle 546 on Post Card

SARCO

Inside story on automatic cooling control

Simple, gadget-free design. Fully modulating. Sensitive liquid-filled thermostat gives you uniform movement of valve for each degree of temperature change, at all points on the range. Packless — no stuffing box — no leaks — no valve stem jamming. Self-contained — no part of mechanism exposed. Dependable and inexpensive — thousands in service. So reasonable in cost, you can afford Sarco automatic cooling controls for every application.

Sarco T-44 self-powered cooling control is available in standard 50° adjustment ranges: 60-110° F., 85-135° F., 110-160° F. and 135-185° F. Sizes: ⅜", ¾", ½" and 1".

For the full story on Sarco Cooling Controls...

contact your Sarco sales representative or district office, or write—

2168

SARCO

SARCO COMPANY, INC.
635 MADISON AVENUE, NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.

scribed various of the newer automatic chemical analyzing and recording instruments being used in power plants today.

Condensers

The session on condensers first considered hydraulic aspects of condenser circulating water systems. Rushen A. Wilson's paper on this subject, coming out of experience at Allis-Chalmers, pointed out that air and vapor tend to separate from water in siphonic piping systems. Degree of separation is a function of the air dissolved and entrained in the incoming water, and the absolute pressure existing in the water circuit, as well as the time the water is exposed to the reduced pressure. The siphonic efficiency of the system will depend on how well the air and vapor are recombined and recompressed, or as an alternate separated and vented out of the system.

Performance tests of water-lubricated bearing materials for condenser circulating water pumps have shown these conclusions: the best performing combinations consisted of carbide running against carbide; leaded bronze and special TFE materials ("filled" Teflon bearing running on stainless steel journals) showed low wear and good life; the usual metal bearing-journal combinations failed rapidly by galling, the plastic materials by surface melting and the ceramics by abrasion; tests of the rubber bearings substantiated the field results of wear on the journal and some hardening of the rubber. These tests were described by F. L. Yetter and Charles H. Diehl of C. H. Wheeler Mfg Co.

Details of a rigorous plant test of a 95,000-sq-ft condenser were given in a paper prepared by three engineers from C. F. Braun & Co. — Wayne E. Glausser, Carl H. Unruh, and Garen Balekjian. The unit tested is in Scattergood Station of the Los Angeles Dept of Water and Power. It is single pass with ⅞-in., 18-gage, 40-ft long tubes of 70–30 copper-nickel. The condenser is rated for 1.5 in. of mercury back-pressure using 78,000 gpm of sea water at 60 F. Design water-velocity is 5.1 fps, and design cleanliness-factor is 73 per cent. Tubesheets are 70-30 copper-nickel, and the water boxes and covers are steel, clad with 70-30 copper-nickel.

The job of sizing a condenser properly is a painstaking one involving many variables. When the unit served is large (300 Mw), even a small improvement in condenser vacuum will result in considerable savings in operating cost. To achieve a more rigorous and refined evaluation in determining optimal condenser size, Commonwealth Edison Co has been using a digital computer in the selection of their recent condensers. A paper prepared by a group of four engineers headed by Marion J. Archbold, General Mechanical Engineer, explained this procedure and indicated that while a digital computer still involves considerable amount of time and labor, it does increase the accuracy and permits the study to cover a great many more sizes and variables.

Computers

Computers and network analyzers were covered by a set of six papers. J. C. Hogan of the University of Missouri and V. E. Verrall of Central Illinois Public Service Co, in discussing equivalent circuits, showed that an equivalent which takes proper account of transformation ratios will give dependable results. They described a step-by-step procedure for measuring such an equivalent without disturbing a network analyzer setup.

Experience at Commonwealth Edison Co with digital computers used in coördination with network analyzers in short-circuit type fault studies was described by Homer E. Brown, George L. Landgren and William M. Thorn. Edison rates this experience as "very satisfactory" and lists these advantages for digital computer solution of fault problems: economy, accuracy, reduction of human errors and availability for re-runs.

James E. Van Ness, associate professor of electrical engineering at Northwestern University, explained the use of the digital computer in solving for the voltages and currents in a transmission system when a schedule of power generation and load is given (load-flow problem).

Both operators and users agree that there is a definite need for some kind of a system for reducing the reading-recording time and errors from network analyzers. Charles M. Emslie of Iowa Engineering Experiment Station discussed this subject and described what has been done at Iowa State to improve the metering system.

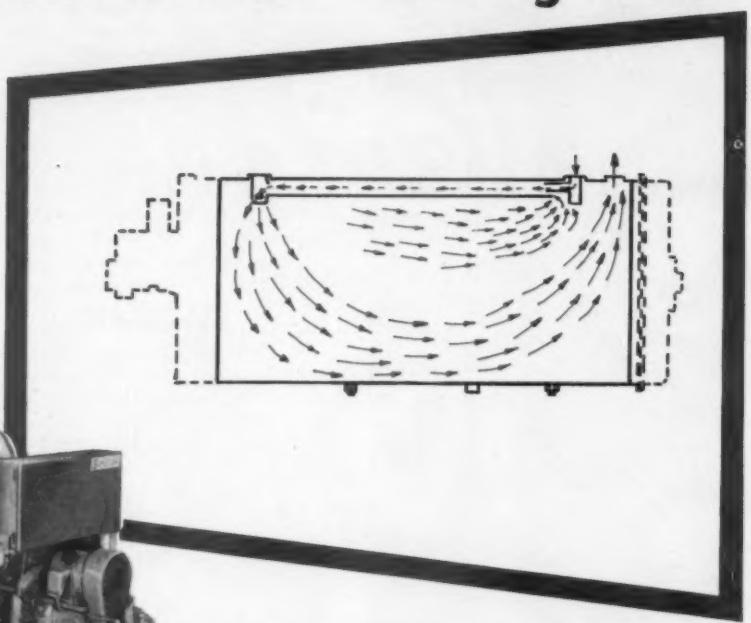
Westinghouse has already designed and is building equipment which automatically prints the output data from an a-c network calculator on a single-line diagram of a power system. This development was described by O. J. Wallace and Rodney E. Gilbreath.

Lionel O. Barthold and Robert E. Silva of General Electric covered the essential techniques and components used in transient network analyzer studies. THE END

NEW from Superior...

a boiler with Venturi-Action Mixing Tube

for Hot Water Heating



For details of the Type CC, the answer to trouble-free hot water heating, write for Catalog CC-12.

Unequal circulation within the boiler . . . a problem of serious consequence in hot water heating . . . has been overcome by a newly developed *Venturi-Action Mixing Tube* which is an integral feature of the new Type CC. The tube plays a triple role:

(1) It starts by mixing entrained water from the boiler with water entering the boiler.

(2) As this mixture travels through the tube, its temperature is further modified by surrounding water.

(3) Jet action at the end of the tube, where flow is directed down and outward at the boiler front, provides an unequalled full-length boiler circulation pattern.

This flow pattern was carefully traced time and again by means of thermo-couples which proved that the mixing action achieved was unequalled in any other hot water boiler.

Specialists in PACKAGED BOILERS . . . exclusively

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR PACKAGED BOILERS

For more data circle 547 on Post Card

HELPFUL BULLETINS

continued from page 33

MATERIALS HANDLING

153 Utility Tractors — Twelve-pp Catalog UT-111 covers utility tractors with matched equipment to enhance their versatility. Points up numerous user advantages — low profile, high clearance, short turning, easy riding, also economy of operation. Photos show tractors at work. Allis-Chalmers Mfg. Co.

154 For Bulk Materials — Six-pp Folder 2721 describes Jetslingers — machines equipped with short, high-speed belt conveyors for hurling free-flowing bulk materials into areas inaccessible by other mechanical means. Illustrates and describes suspended, swiveling and wheel-mounted units for hurling material into storage in warehouses, boxcars, holds of ships, bins, on the ground. Link-Belt Co.

155 Belt Conveyor Idler — Presented in 20-pp Bulletin LD-111 is a belt conveyor idler consisting of Neoprene discs molded to a Neoprene-covered, flexible steel wire cable suspended from two end-mounted bearings. Contains specifications, description of construction features, installation photos, and application instructions. Joy Mfg. Co.

156 Idler Selection Guide — Details of construction, comparison of competitive designs, and selection data on belt conveyor idlers are presented in 48-pp Bulletin 171. Illustrates and describes basic types of idlers in all types of service, and includes procedure and examples, engineering tables, dimensions and specifications. Hewitt-Robins, Inc.

INSTRUMENTS

157 Pressure Gage — Bulletin DH-333 describes heavy-duty, multi-purpose, general utility gages featuring a geared movement for oil, air, water, steam, gas or other media not corrosive to brass or bronze. Engineering data showing construction details, features, applications, specifications, pressure ranges, and dimensions are included. Helicoid Div., American Chain & Cable Co., Inc.

158 Industrial Gages — Detailed information on a line of plug and ring gages, standard and special, and on both thread and plain gages, is presented in 26-pp Catalog 59-S. Charts are included giving tap recommendations for classes of threads, and screw thread standards. Regal Div., Beloit Tool Corp.

159 For Process Industries — Gages and instruments for the process industries, including pressure and vacuum gages, indicating pneumatic controllers, and pneumatic transmitters, are featured in Bulletin 3015. Includes construction details. United States Gauge Div., American Machine and Metals, Inc.

OTHER EQUIPMENT

160 Annunciators, Systems — Detailed information on annunciators and annunciator systems is presented in Bulletin 440. Describes unitized construction of

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY —

POWER ENGINEERING
308 East James St.
BARRINGTON, ILLINOIS

FIRST CLASS
PERMIT No. 11
Sec. 34.9 P.L.&R.
BARRINGTON, ILL.

POWER ENGINEERING
MAY, 1960

Please have manufacturers send me, without cost or obligation information or literature indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....City.....State.....

(If you prefer delivery at home, give home address, too)

Home Address.....City.....State.....

Equipment								Helpful Bulletins											
1	2	3	4	5	6	7	8	101	102	103	104	105	106	107	108	109	110	111	112
9	10	11	12	13	14	15	16	113	114	115	116	117	118	119	120	121	122	123	124
17	18	19	20	21	22	23	24	125	126	127	128	129	130	131	132	133	134	135	136
25	26	27	28	29	30	31	32	137	138	139	140	141	142	143	144	145	146	147	148
33	34	35	36	37	38	39	40	149	150	151	152	153	154	155	156	157	158	159	160
41	42	43	44	45	46	47	48	161	162	163	164	165	166	167	168	169	170	171	172
49	50	51	52	53				173	174	175	176	177	178	179	180				

Advertised Products and Services																			
501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
601																			

Use this space for tear sheets or other information wanted.....

.....

.....

(This card VOID AFTER AUGUST 31, 1960)

POWER ENGINEERING
MAY, 1960

Please have manufacturers send me, without cost or obligation information or literature indicated by the numbers circled below.

Name.....Title.....

Company Name.....
(Must be included)

Company Address.....City.....State.....

(If you prefer delivery at home, give home address, too)

Home Address.....City.....State.....

Equipment								Helpful Bulletins											
1	2	3	4	5	6	7	8	101	102	103	104	105	106	107	108	109	110	111	112
9	10	11	12	13	14	15	16	113	114	115	116	117	118	119	120	121	122	123	124
17	18	19	20	21	22	23	24	125	126	127	128	129	130	131	132	133	134	135	136
25	26	27	28	29	30	31	32	137	138	139	140	141	142	143	144	145	146	147	148
33	34	35	36	37	38	39	40	149	150	151	152	153	154	155	156	157	158	159	160
41	42	43	44	45	46	47	48	161	162	163	164	165	166	167	168	169	170	171	172
49	50	51	52	53				173	174	175	176	177	178	179	180				

Advertised Products and Services																			
501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520
521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540
541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560
561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580
581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600
601																			

Use this space for tear sheets or other information wanted.....

.....

.....

(This card VOID AFTER AUGUST 31, 1960)

BUSINESS REPLY MAIL
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER ENGINEERING
308 East James St.
BARRINGTON, ILLINOIS

FIRST CLASS
PERMIT No. 11
Sec. 34.9 P.L.&R.
BARRINGTON, ILL.

signal relay plug-in units and others. Tigerman Engineering Co.

161 **High Velocity Units** — Catalog HV-70 contains 24 pp of application and performance information on a line of high velocity air distribution systems. Includes dimension drawings and tables as well as cfm capacity, static pressure and radius of diffusion rating. Anemostat Corp. of America.

162 **Heating, Cooling Coil** — Bulletin M-8 describes advantages and applications of company's panelcoil for heating and cooling. Illustrates and describes standard types, and illustrates construction features. Dean Products, Inc.

163 **Feedwater Heaters** — Construction details and operating features of company's feedwater heaters are described in 16-pp Bulletin YHT 102. Illustrates and describes component features and includes photos of typical installations. Yuba Consolidated Industries Inc.

What? No CATALOG LIBRARY?

No, not this month or next. . . . This long-time monthly reader service is being replaced by a greatly expanded catalog supplement due to appear for the first time in August. It will make available more catalogs on more subjects of current interest to power engineers.

164 **Industrial Apparel** — Acid and caustic resistant industrial apparel is described in this 16-pp 1960 Catalog. Characteristics and resistive qualities of Dacron and Dynel fibers are detailed, and a swatch card of actual samples is included with booklet. Worklon, Inc.

165 **Gas Scrubbers** — Application, construction and operation information on gas scrubbers and cyclones is presented in 12-pp Bulletin 4R. Tables of gas handling capacities for different water pressures, drafts, and scrubber sizes enable selection of proper type and size to meet specific plant operating requirements. Schutte and Koerting Co.

166 **Pipe-Fitting Insulation** — Molded fiber glass pipe-fitting insulation is featured in Bulletin TD-105. Describes features and advantages and includes specifications and dimensional data. Fibrous Glass Products, Inc.

167 **Protective Coatings** — This 16-pp industrial catalog contains detailed selection and application data on protective coatings for new or rusted metal. A selector guide evaluates technical properties of various coatings, and actual paint chips facilitate color matching. Master Bronze Powder Co., Inc.

168 **Pressure, Vacuum Filters** — Features and advantages of company's pressure and vacuum type diatomaceous earth filters are detailed in Bulletin B6002. Various components and element types are discussed and diagrams of operation procedures shown. General Filter Co.

Improved Water Level Indication • Better Visibility

with Exclusive New Construction*

Diamond

MP-3000 MULTI-PORT BI-COLOR GAUGE

*Patented

New patented construction of the Diamond MP-3000 Multi-Port Bi-Color Gauge is illustrated by cut-away sections.

This improved construction (exclusive with the Diamond MP-3000 Multi-Port Bi-Color Gauges) avoids possible confusion of colors in steam space of gauge and it improves visibility by providing sharper red and green colors.

Condensate, which might otherwise be a source of trouble, flows down the bypass channel instead of down the port channel. This permits the center plate to retain a relatively high temperature so that water in the ports is nearer to temperature of water in the boiler drum, improving indication accuracy. Absence of condensate in the ports assures a distinct Bi-Color image—signal red for steam—signal green for water.

Multi-Port construction greatly reduces gauge maintenance costs. Inherent thermal stability minimizes maintenance frequency and any port can be changed in a few minutes without removing the gauge from the boiler. Change of any port is expedited by new glass and gasket package unit. Construction is exceptionally sturdy—gauge body is machined from a solid block of high grade stainless steel. Get in touch with your local Diamond office, or write us at Lancaster, Ohio, P.O. Box 415, for complete information and bulletins.

DIAMOND POWER SPECIALTY CORP.

LANCASTER, OHIO

8364

DIAMOND SPECIALTY LIMITED • WINDSOR, ONTARIO

For more data circle 548 on Post Card

EQUIPMENT NEWS

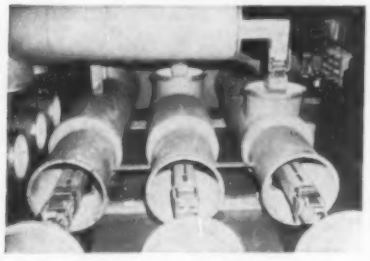
Described on these pages are new and improved products. Use Reader Service Cards on pages 105–106 to ask for more information on them. Just circle the item numbers of all the products in which you are interested.

1—WALL DESLAGGER is air-powered, fast working

The Vulcan RW-3A Wall Deslagger is air-powered and reported to complete a normal cleaning cycle in less than 73 sec. This high-speed operation is made possible by two separate air drives. One extends and retracts the nozzle almost instantly; the other rotates the nozzle slowly for thorough cleaning. Standard nozzle travel is 12 in.; 24 in. is available. Each deslagger in a sequence can operate in succession, so that the sequence can be repeated as often as needed. The blowing medium may be air, saturated or superheated steam, or any combination. The deslagger is designed for easy maintenance, has one external stuffing box and has no threads or working parts in the path of the blowing medium, or exposed to dirt. A similar deslagger with dual electric drive is available. Copes-Vulcan Div., Blaw-Knox Co.

2—BUS DUCT reduces circulating currents

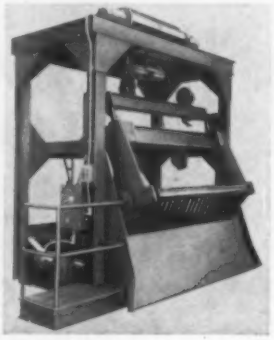
This isolated phase bus, for generator station service, is designed to reduce circulating currents that result in power losses. The duct is so arranged that longitudinal currents will circulate in the conductor enclosures at all times. This circulation minimizes the problems associated with induced currents which can occur in structural members



which lay parallel to the plane of three-phase bus duct. Featuring field welded enclosures, the bus also reduces voltage build-ups between enclosures and ground, manufacturer notes, and its design retains company's single-insulator conductor support principle. It can be self-cooled, forced-air cooled or furnished for 105 F high temperature operation. General Electric Co.

3—TRASH RACK RAKE cleans, and dumps its load

The self-dumping log grapple trash rack rake has its teeth retracted when descending with sufficient space between the rack bars and the teeth on the basket



to clear the accumulated trash against the bars, cleaning the trash and dumping it into a car that is carried along the hoist car. The rake is available in several models in 6- to 12-ft sizes. It is suggested for use by power plants and water and sewage works to free water intakes of branches, boxes, cans, other rubbish. Allis-Chalmers Mfg. Co.

4—COMBUSTION CHEMICAL protects oil-fired boilers

Nalco 159, a combustion chemical designed to protect residual oil-fired boilers against slag and cold-end corrosion, is a clear, oil-soluble liquid. Tests are reported to show it effective in protecting air heater and economizer sections of residual oil-fired boilers, and in reducing fouling by slag throughout the furnace. It protects boiler fireside surfaces by interrupting high temperature reactions that cause oil ash constituents to form slag, manufacturer states, and it poisons catalytic surfaces that promote sulfur trioxide formulation. Nalco Chemical Co.

5—COMPACT SWITCH for electrostatic precipitators

Although intended for distributing power from rectifiers to electrodes of electrostatic precipitators, this high voltage switch may also be used with other types of equipment having high voltage-low current characteristics. A multi-deck rotary type designed to operate in all types of insulating oils, it may be housed in its own compartment, in which it requires about 1 cu yd of space. Or it may be immersed in the same compartment as the transformer-rectifier, in which case the compartment is lengthened or widened.

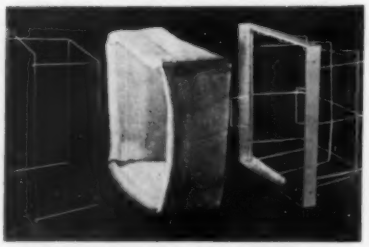
Compact design results in a lower-cost component per se, it is noted, also reduced space requirements when located indoors and less congestion in confined quarters when installed on the precipitator roof. It is pointed out that the totally enclosed switch offers freedom from corrosive effects of atmospheric elements and possible deposits of airborne dusts, as well as safety advantages, as personnel do not come in contact with live parts. The switch is engineered for 100,000 v and 1 amp. Switch action is double-blade type and large surface contacts are designed to withstand brief, but steep, feedbacks inherent in precipitator operation. Switch can be operated under load, if necessary. Buell Engineering Co., Inc.

6—TRANSMISSION FLUIDS offered in two types

Two new automatic transmission fluids — Type A-Suffix A and Type C — are announced as having flash points above 400 F, some 65 to 85 deg above usua flash points of only 315 to 335 F for such fluids. According to company, this thermal stability results from blending oils used in the manufacture of the fluids; and the higher thermal resistance prevents these fluids from "breaking down" under extreme operating conditions. An oxidation inhibitor is another ingredient of the fluids. Both are claimed to have no harmful effects on rubber seals and to possess improved low temperature viscosity characteristics. Lubrication Engineers, Inc.

7—CUBIC AIR FILTER offers longer service life

ULOK Cubic Air Filters are "cube" replacement units said to last six times longer than most throw-away and permanent metal type filters. High capacity filtering action is attributed to a lightweight Dynel modacrylic filtering medium, and open-side cube construction. These filters are for use in air-conditioning and heating, dust entrapment, and process air systems. Shaped like an open



box the unit is made of three components: the disposable high loft, 2-in. thick filter medium; a "basket" or retainer, into which the medium fits; and a retainer wire that fits inside the medium.

In operation, the air stream carries dirt into the cube to the front surface of the downstream face of the filter. As dirt builds up on the downstream face, air flow is shunted to the sides of the cube. Coarse material continues to be caught on the downstream face while the large filter area of the four sides traps the fines, manufacturer explains, and the result of this progressive "reverse loading" is that the unit shows unusually low pressure drop even after collecting several pounds of dirt. Filters are UL listed as Class II, and are available with standard face areas of 20-by-20, 20-by-25, 16-by-20 or 16-by-25 in. For each of these there are units measuring 8, 11 and 20 in. in the direction parallel to the air

TURBO-COMPRESSORS AND BLOWERS

2500 cfm and up

By Eugen P. Eicher, M.E., Brown Boveri Corp.

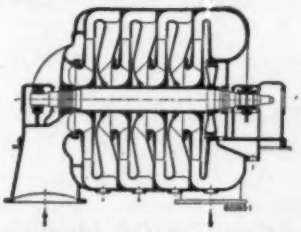
BROWN BOVERI

Brown Boveri offers complete compressor sets including compressor, choice of drives and all auxiliary equipment. Brown Boveri manufactures all the components, assembles and tests the complete sets in their own workshops and assumes full responsibility for the complete unit.

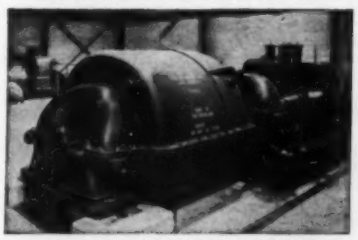
Compressors include a full range of centrifugal and axial types. Drives include steam turbines, gas turbines, expander turbines and electric motors. (Where hot waste gases are available, for example, a combination of motor-generator and exhaust-gas expander turbine drives has reduced power costs 60 to 70%.) Auxiliary equipment includes gear sets, pressure and volume regulators, air and gas coolers and complete electrical control systems.

Brown Boveri compressor sets are used by many leading U. S. companies and are backed by engineering skill, product reliability, and complete U. S. service staff and facilities.

2500 to 175,000 cfm at up to 60 psi* Uncooled centrifugal blowers



Four-stage centrifugal compressor.



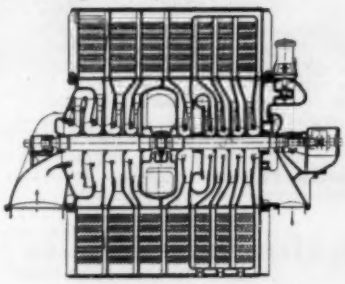
One of two 40,000 cfm centrifugal blowers with steam turbine drive in a copper conversion plant, Arizona.

First developed by Brown Boveri. Advantages over reciprocating compressors in the above ranges: lower cost, higher efficiency, less maintenance, less floor space and *clean, oil-free air.*

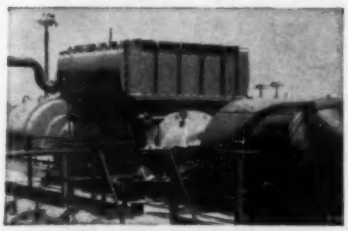
Standard designs are for air or non-poisonous, non-corrosive and non-explosive gases. Stainless steel impellers, shafts, etc. are available for corrosive gases. High-pressure casings and oil type sealing glands are available for higher pressures.

Applications: Blast furnaces, converters, coke ovens, gas distribution, process air and gases, air separation plants, sewage aeration, tunnel ventilation.

5000 to 80,000 cfm at 60 to 120 psi* Internally-cooled "Isotherm" centrifugal compressors



Nine-stage "Isotherm" compressor with anti-surge power-recovery turbine.



"Isotherm" compressor driven by a synchronous motor (left) and a waste-gas recovery turbine (right) at a California chemical plant.

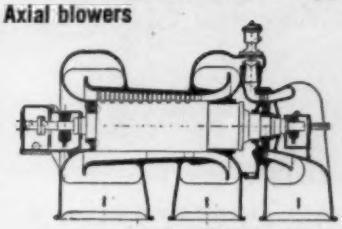
Highest inherent efficiency. Ten basic models with 6 to 9 stages per casing. Impeller diameters from approx. 1 ft. to 4 ft. The larger models include a built-in power-recovery turbine to allow running at loads below the surge limit.

Stainless steel impellers, shafts, etc. are available. For discharge pressures higher than 120 psi, "Isotherm" compressors are followed by an uncooled centrifugal compressor or other booster.

Drives: Four-pole synchronous motors are generally preferred for 1500 hp and larger units, other type motors for smaller sizes. Speed-increasing gears are used with all motor drives. Variable-speed steam or gas turbines are direct coupled.

The reliability of "Isotherm" compressors is proved by hundreds of installations in mines, shipyards, chemical process plants, air liquefying plants, aerodynamics laboratories.

10,000 to 500,000 cfm at up to 80 psi* Axial blowers



Ten-stage axial compressor with anti-surge power recovery turbine.

Axial blower, steam turbine drive, supplying 70,000 cfm of air for a blast furnace.

Substantially more efficient than centrifugal units for large air volumes where adequate pressure can be delivered with a single unit and without cooling. The higher efficiency allows smaller and better drives and lower cost. A power-recovery turbine may be built in to permit operation at volumes below the surge limit.

Drives. Steam turbines allow simple, automatic control through Brown Boveri pressure-oil governors with pressure or volume regulator. Brown Boveri gas turbines and electric motor drives of all types are also available.

Applications: Gas turbines, wind tunnels and chemical plants. In Europe, Brown Boveri axial compressors driven by gas turbines are widely used for blast furnace air with substantial power savings.

**Capacities for single machines. Higher discharge pressures can be obtained by combining various types of equipment in series.*

BROWN BOVERI

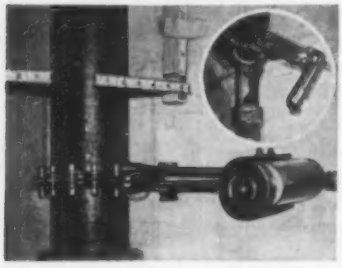
U. S. Sales and Engineering: Brown Boveri Corp., Dept. PE-5, 19 Rector Street, New York 6, N. Y. Agents in 27 U. S. cities.

For more data circle 549 on Post Card

stream. Company says that the area of a bank of filters required for a given job may be halved by switching from flat filters to the 20-by-20-by-8 in. ULOKs. Filter disposal is simple. When filled to operating capacity, the filters may be collapsed and discarded. The dust is in the bag. Union Carbide Development Co., Div., Union Carbide Corp.

8—PIPE CUTTER is hydraulic powered tool

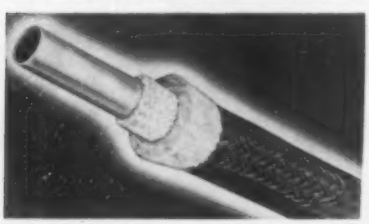
The Wheeler Jr. Hydraulic Cutter uses hydraulic power to handle all capabilities of company's manual cutter in addition to 8-in and extra-heavy soil pipe as well as 2- and 3-in. cast iron water main. It is reported ideal for use in close quar-



ters and on overhead installations; the heavy-duty hydraulic pump may be operated remotely from the actual cutting location. The unit is described as light in weight and compact, but ruggedly built and requiring no special adjustment. The chain is simply wrapped around the pipe and the nearest chain pin engaged in the jaws. The pump is then operated until the cut is made. Cutter is supplied with enough cutting chain to accommodate 2- through 8-in. pipe. Additional chain may be added to extend capacity. Wheeler Mfg. Corp.

9—SLIP-ON COVERING is flexible piping insulation

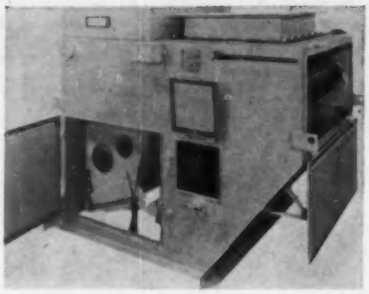
Unarco Insutube is a lightweight noncombustible flexible tubing for temperatures from 50 to 500 F, for insulating bent piping or tubing where rigid material would be impractical. It is also suggested for insulating flexible connecting lines and for conditions of severe vibration. The product consists of



three basic parts: A braided asbestos inner tubing; a lightweight fibrous-glass insulation; and an outer covering jacket of braided asbestos tubing. Insutube is available with an uncoated outer jacket, or with outer jacket coated with an oil and abrasion resistant, self-extinguishing synthetic rubber. A heat-sealed plastic liner vapor barrier inserted between outer jacket and fibrous glass insulating medium is also available. Tubes are ½ in. thick, available in sizes from ¼ to 2 in. Fibrous Products Div., Union Asbestos & Rubber Co.

10—COAL SCALE features larger access doors

Access to all parts of the redesigned H-39C Automatic Coal Scale is facilitated by unusually large access doors. These big doors are provided on all four sides of the scale; when closed, they fit flush with the inside walls to eliminate dust accumulation. Stainless steel latches are provided to prevent corrosive effects of binding, and seals are of monocellular Neoprene as a precautionary measure against pressure or dust seepage. There are three models: 200 lb (20 tons per hour capacity): 500 lb (40 tons per hour capacity): and 1000 lb (60 tons per hour). Another feature is a self-energizing by pass, in which the force of gravity of the coal



supply provides by-pass power. A trip of the trigger releases the mechanism. Richardson Scale Co.

11—SOOT REMOVER to be sprayed on boilers

Liquid Soot-Ban, applied to boilers with an industrial sprayer, is said to do more efficient cleaning in less time and to make vacuuming unnecessary in many instances. It adheres to the soot on vertical as well as horizontal surfaces, says manufacturer; it lowers the combustion point of the carbon so that it burns away rapidly, but not violently, when ignited with a paper torch. For use in all types of furnaces, heaters and oil burners, Liquid Soot-Ban is described as non-inflammable and harmless to metals. Company includes an industrial sprayer with a 55-gal drum of product. Parke-Hill Chemical Corp.

12—METAL TREATMENT now dries in half the time

In the average application, improved Ospho dries in about half the 12 hr formerly required for this metal treatment, due to the addition of a new drying agent. Ospho is applied directly on rusted metal; it acts to chemically change rust (iron oxide) into iron phosphate, an inert surface which provides a base for regular maintenance paint. It is also said to provide a good bond between new metal and paint. Rusticide Products Co.

13—MANIFOLD simplifies the instrument connections

Designed to provide a simpler and more dependable means of making instrument connections to flow meters, level indicators, and others, the Yarway Manifold combines three valves in one. Two of these provide line shut-off and one equalizes pressures to protect the instrument's internal working parts — together with a connection tap for calibration of the high pressure side of the system. The manifold is furnished with screwed or socket-weld end connections. Body and working parts are stainless steel. Bulletin RI-1825 (Supplement C) gives data. Yarnall-Waring Co.

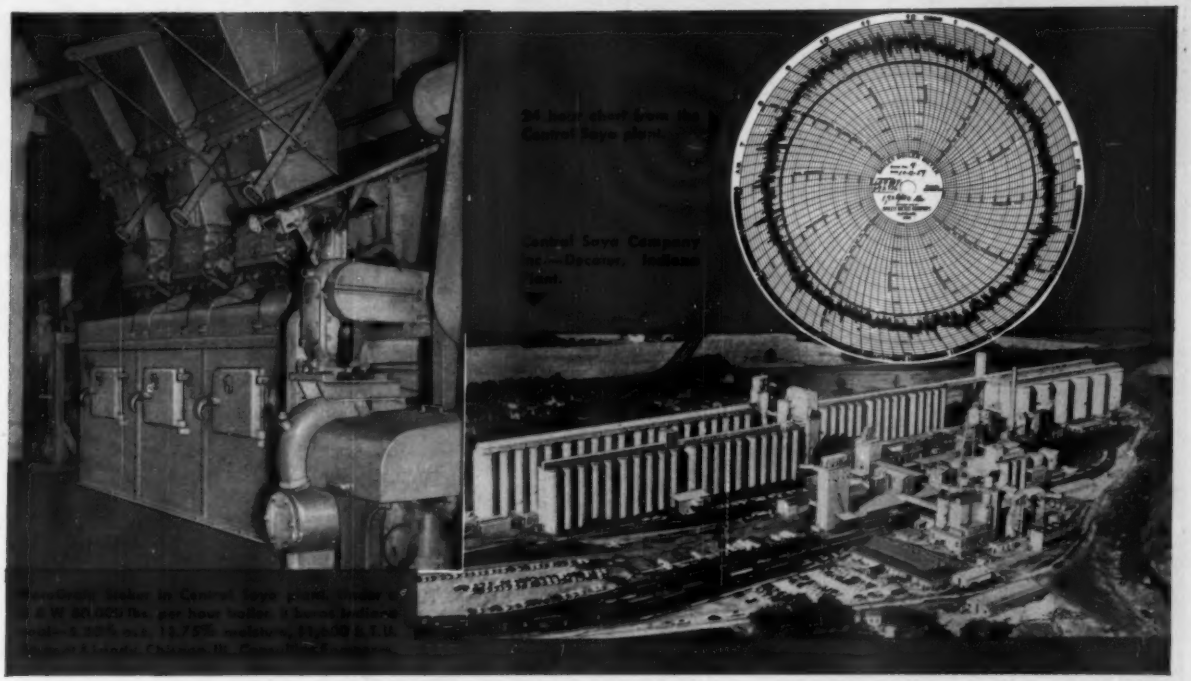
14—TRANSMITTERS are universal indicators

Model 45 Series of pneumatic indicating transmitters for pressure, flow, temperature, liquid level, differential pressure, and dew point feature measuring elements specifically designed for each major process variable. The transmitter is available with measuring elements in the following ranges: pressure — 0–10 in. water to 0–80,000 psi; temperature — 450 F to 1000 F (−270 C to 500 C); flow (differential pressure) — 0–1 to 0–400 in. water; liquid level — open vessels 0–10 in. water minimum, closed vessels 0–20 in. water minimum; dew point — −50 F to 165 F. Output signal is 3–15 psi (3–27 psi optional). The transmitter operates on a 20 psi air supply. Manufacturer says the Model 45 has high ambient temperature stability, with less than ½ per cent error for ambient temperature changes as great as 50 F, regardless of variable measured, and overall calibrated accuracy within ±½ per cent. Featuring link and lever calibration and a minimum of moving parts, the Model 45 is said to be easy to adjust and maintain. Its 6⅛-in. scale and fluorescent pointer provide visibility local indication. The Foxboro Co.

15—ANNUNCIATOR identifies the off-normals sequentially

Model 51-DS is a digital sequential annunciator designed to identify the sequence in which a group of alarms occur. Any number of total alarm points can be handled. Three variations are available whereby up to seven, 15 or 31 off-normal

points may be sequentially identified by clear binary readout, with resolution between points in milliseconds. For example, the sequential "7" variation consists of three lamps numbered "1" "2" and "4" above each alarm window, permitting readings from one to seven by summation. The Model 51-DS is reported especially valuable in monitoring complex processes where any one or



8 Years of Stoker Operation
Without Forced Outage

DETROIT ROTOGRATE AVAILABILITY AT CENTRAL SOYA COMPANY INC.

Hersel Nash, Steam Power Superintendent of Central Soya Company, Inc., Decatur, Indiana Plant says: "Our 80,000 pounds per hour, 600 psig boiler with Detroit RotoGrate Stoker has carried loads similar to the accompanying chart for 355 days per year for eight years (we have the boiler down for inspection and cleaning once each year, for about 10 days.)"

"During this time we have burned about 300,000 tons of Indiana coal without ever losing the load because of the stoker. Our monthly efficiencies average 85% to 86%. This is above the manufacturer's predicted performance."

This 'round the clock—seven days a week operation year in and year out with high economy proves the rugged stamina and ability of the RotoGrate . . . shows why it has long been first choice among operators and top management alike.

Built to serve steam generators up to approximately 400,000 pounds steam per hour capacity, the RotoGrate is one in a complete line of Detroit Stokers . . . overthrow spreader and underfeed types for commercial, industrial and utility boiler plants—also for incineration of both municipal and industrial wastes.

DETROIT STOKERS COST LESS Cost equals initial investment plus upkeep, plus production losses due to equipment outage. *The total is less with Detroit.* Ask for Bulletin.

DETROIT SINCE 1898 STOKERS

DETROIT STOKER COMPANY
DIVISION OF UNITED INDUSTRIAL CORPORATION
MAIN OFFICE AND WORKS • MONROE, MICHIGAN
District Offices or Representatives in Principal Cities

For more data circle 550 on Post Card

WATER FOR BOILERS NEEDS DEOXY-SOL

- to remove O_2
- reduce oxides
- raise pH

Fairmount DEOXY-SOL, a solution of hydrazine, is a high efficiency oxygen scavenger designed especially for high pressure boiler water treatment.

DEOXY-SOL removes oxygen, reduces oxides and raises pH of the condensate all at the same time . . . yet adds no solids.

Stocks in Newark, N. J., Chicago, Ill., Los Angeles, Calif. Investigate its advantages for your system. Write for Bulletin BW.

Fairmount
CHEMICAL CO., INC.
136 Liberty St New York 6 N. Y.

For more data circle 551 on Post Card

more of many factors can cause automatic shutdown. Alarms are audible as well as sequentially visible. Panellit, Inc.

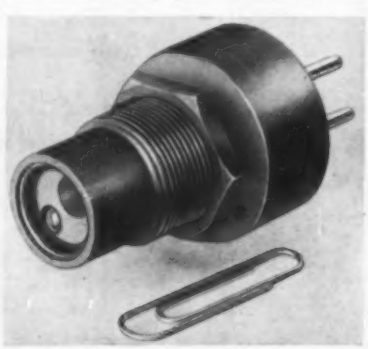
16—BUNKER CUSHION serves to prevent flow stoppages

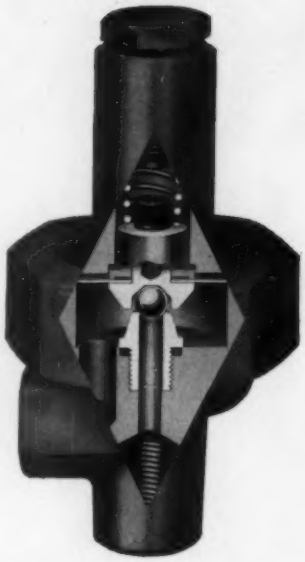
Pneumatic Clouth Bunker Cushions are intended to eliminate flow stoppages in bins and hoppers handling materials which tend to funnel, bridge,

cake and otherwise hang up. When inflated with 45 psig, the cushion exerts a force of approximately 56,000 lb, manufacturer states, and its operation doesn't jeopardize personnel safety or generate fatigue stresses. Basically, the cushion consists of a rubber diaphragm bolted to a reinforced steel base which includes both inlet port and exhaust valve. It measures 31.5 by 39.4 in. when installed, and reaches an operating height of 15.75 in. Rubber shock cords connect membrane and exhaust valve, thereby providing mechanical control. Deflation cannot occur until the cushion has reached its full height, it is explained, and in addition, the cords serve to actuate the exhaust valve and relieve shock load stresses caused by the sudden removal of opposing load or falling materials. Tressler Engineering Products Div.

17—SCANNER combines light source and photocell

With energy source and detector combined in a single unit only 2½ in. long, 1⅛ in. in diameter, the Farmer Type SA-IR Infrared Photoelectric Scanner, or Proximity Sensor, is designed to respond to metallic and non-metallic objects and provide a simple and easily installed means for handling a variety of counting and control operations. It senses objects or control areas at distances up to 2 in. The infrared source is rated at 60,000 hr when operated at 5 v a-c. The solid-state detector is sealed to protect against moisture, dust





THIS PREMIUM RELIEF VALVE PROVIDES ABSOLUTE SAFETY IN CORROSIVE SERVICE

- The Milton Roy full-lift design assures immediate and positive relief when the set pressure is reached, yet there's no chattering or leakage as the relief valve approaches its set pressure.
- Continued leak-free operation is assured even after the valve has opened in corrosive service, because topworks are completely isolated from the process stream by a Teflon diaphragm.
- Wetted parts are available in steel, 316 stainless, Carpenter 20 stainless, Hastelloy "C" or "B", or PVC. Sizes range from ¼" up for pressures to 1500 psi. Back pressure valves are also available.

For complete information, request Bulletin 357-2 from Milton Roy Co., 1300 East Mermaid Lane, Philadelphia 18, Pennsylvania.

milton Roy
CHEMICAL INSTRUMENTATION SYSTEMS

Controlled Volume Pumps • Quantichem Analyzers
Chemical Feed Systems • pH Instruments

For more data circle 552 on Post Card

or corrosive atmospheres. An infrared filter minimizes effects of ambient light. The anodized aluminum housing has provision for mounting in a ¾-in. hole. A standard four-prong base permits plug-in connection to control circuit. Farmer Electric Products Co., Inc.

18—SYNTHETIC ROPE for pulling in overhead conductor

Penco-Prope is especially designed for pulling in overhead electrical conductor on transmission and distribution lines. Manufacturer says it has excellent dielectric characteristics, is waterproof, is not adversely affected by salt water, and can be left in the weather as it will not mildew. It is described as strong and very light, and satisfactory for tension stringing. It handles and splices like manila, company states, but due to its greater strength, smaller diameters can be used. It is noted that where wire rope has previously been necessary for heavy transmission line stringing, Penco-Prope can usually be used because of its strength and ease of handling. Peterson Engineering Co., Inc.

19—FILTER MEDIA KITS to assemble at point of installation

Available in kit form, the Manual Roll-Kleen is designed to operate in a pressure differential range from 0.3 to 0.6 wg and from 350 to 500 fpm. It is said to provide high performance, low cost installations. For assembly at point of

installation, the kit carries media rolls 70 ft long in widths for 3-, 4- or 5-ft wide filter sections. Unit heights range from 5 to 15 ft. Two or more sections can be bolted together; structural members are heavy-gage steel. The manual wheel changes media quickly, rolling used media down across the face of the filter to the lower disposable roll. Maintenance is infrequent except under extreme conditions, manufacturer states, and is signaled by a warning light or standard draft gage. Farr Co.

20—TREATMENT FEEDER for cooling water systems

Hydrotrol is announced as a new type of water treatment feeder and controller for use with recirculating cooling water systems to prevent corrosion, mineral scale, slime and algae. It is claimed to eliminate "drift" of treatment and simplify treatment control. With Hydrotrol, "bleed off" and chemical feed are adjusted automatically, company notes, so that rate of chemical treatment feed and bleed off are always in direct proportion

This maintenance engineer is

Seveneering" with R/M

to overcome high breakaway friction

At the suggestion of his local R/M packing distributor, he is installing R/M Big 7 Packing Type #4 (oil-resistant packing R/M No. 376) because it is engineered to resist the destructive action of the high breakaway friction met in handling tar, asphalt and other viscous materials. Particularly adapted to refinery and pipeline equipment, such as reciprocating pumps, valve stems, and fluid end rods, it is made of exceptionally high-grade asbestos yarns with braid-over-braid construction. And each braided jacket is sealed with an oil-resistant compound that is unaffected by the action of petroleum derivatives.

When packing general acid processing equipment, he will use R/M No. 380—another Type 4 packing—made of crocidolite (blue asbestos) fiber impregnated with an acid-resistant lubricant.

Whatever your packing requirement, join the thousands of maintenance men "Seveneering" with R/M to reduce inventory and eliminate selection error. They know R/M's Big 7 Packings are engineered to do the job without compromise.

R/M Big 7 Packing Types are stocked by your authorized R/M distributor. Call him today. He will help solve your packing problems and supply your needs immediately from his stock, supplemented by R/M's strategically located warehouses.

R/M's Big 7 packing types meet 95% of all packing needs, are sold exclusively through authorized R/M distributors

This new R/M Big 7 Chart is a mighty handy reference. Send for your copy now.

BIG 7 PACKINGS

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

For more data circle 553 on Post Card

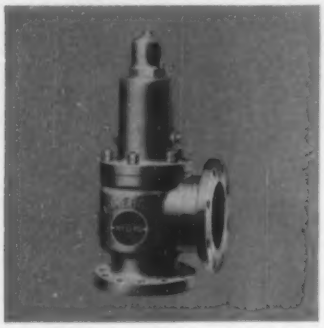
THE LONERGAN LINE

HOW TO SAVE WEAR AND TEAR ON MEN AND VALVES

by A. J. Schmidt, Chief Engineer

Power plant users of relief valves in liquid service are undoubtedly all too familiar with chattering. Valves hammer away, annoying plant personnel and running up maintenance bills.

Even with this undesirable operation, these



valves have been acceptable for application where the valves are seldom, if ever, called upon to relieve. For use under critical applications, such as pump by-pass, where the valve is normally open, or where opening is a common occurrence, it has been necessary to use expensive diaphragm or piston operated valves to eliminate objectionable chattering.

A new series of valves, called Lonergan Hydro-Valves have been under test in dozens of leading plants for the past three years. As a result, Lonergan can provide power plant operators with a valve that is guaranteed not to hammer, chatter or drum on any application, by-pass or emergency relief. At the same time, full-rated liquid flow is maintained. The chatter free operation is provided by a patented, unique design of throat, seat and baffle construction. Use of the Hydro-Valve helps to: save human nerves; prevent loss of plant fuel or product; reduce maintenance on valves and piping; and eliminate interference with delicate control systems. Hydro-Valves are available in all regular body and trim materials in sizes ranging from 1 to 8 inches.

Full details and descriptions are available in our new Hydro-Valve bulletin. Why not write for your copy today?

Alvin J. Schmidt

Lonergan

J. E. LONERGAN CO., 207 RACE STREET
PHILADELPHIA 4, PA. SINCE 1872

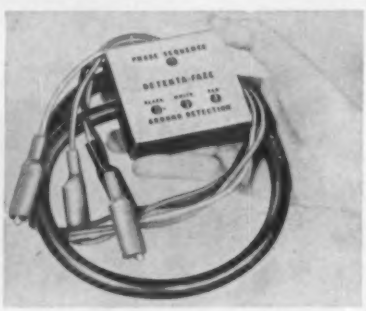
For more data circle 554 on Post Card

to rate of water evaporation or the cooling load on the system.

Foremost among advantages cited are savings up to 95 per cent in water analyses, control labor and attention required. Hydrotrol is also said to enable worthwhile savings in chemicals and water. It may be used with either acid or alkaline treatments. A Hydrotrol controller without feeder can be added to existing chemical feed pump installations. Heller Laboratories, Inc.

21—PHASE SEQUENCE UNIT is ground fault detector, too

Detekta-Faze lets you predetermine the direction of rotation for a motor without starting the equipment, says manufacturer, and it contains no switches, moving parts or batteries. The low cost,



compact unit weighs only 11 oz, measures only 2¾ by 2½ by 1 in., and is self contained. Only one light is used for phase direction, and that light is either on or off, depending on the direction of rotation. Detekta-Faze can be used on two phase-three wire systems and three phase-three and four wire systems, within an operating range of 200 to 500 v, 60 cycles a-c. The built-in ground fault detector is effective for two or three phase-three wire ungrounded systems. Detekta-Faze has no binding posts. A heavy duty cable is attached to the case and the four color-coded leads each terminate with insulated alligator clips. The instrument sells for around $20.00. The Glo-Lite Instrument Co.

22—AIR RAPPERS for precipitators, collectors

Air Rappers for electrostatic precipitators and dust collectors are made with a one-piece design claimed to eliminate 80 per cent maintenance problems on such equipment. Air Rappers have no assembly bolts to stretch and shear, company says, or separate striking plate to leak air from housing. Exhaust parts on both sides of housing keep vibrator piston centered. The units can be arranged with a solenoid valve and timer for complete automatic control. For vertical (Model BH-3) or horizontal (Model BH-3-SP) mounting, units measure 10½ in. long by 5 in. wide by 9¾ in. high, weigh 52 lb; air consumption at 50 psi is 9 cfm. National Air Vibrator Co.

23—DIAL THERMOMETERS for piping installations

Features announced for these mercury actuated dial thermometers include ease of reading and accuracy throughout working range, uniform scale for the

FRANSET
with super bond

Revolutionary new mortar gives you a stronger bond-protects your brick dollars

Colloidal bond used in Franset SB is shown during digestion cycle.

Resists joint penetration—has low iron plus five other features. It doesn't make sense to be careless about your bonding material when you're so careful about your brick. Particularly when brickwork is only as strong as its joint. But you can protect your Company's brick dollars with Franset With Super Bond. It's the first and **only** mortar with this special colloidal bond having twice the bonding strength of many well known joint materials.

Franset With Super Bond has even more benefits.

low iron—Less than 1% iron means greater resistances to carbon and reducing atmosphere, high sulphur oils, etc.

high or low duty service—It can be used up to 3000°F.

workability plus—It's easier to trowel, adhere and to work because of unusual plasticity, no settling or remixing either.

non-shrinking joints—There's no shrinking of joints either.

corindon-kyanite combination—Corindon-Kyanite combination base materials give added stability, higher fusion and higher slag resistances. It's quality controlled too with consistency from drum to drum—unlike some well known mortars.

Don't let us alone convince you of the merits of the first mortar with colloidal Super Bond. Join our hundreds of users!

Protect your Company's brick dollars now—before you have a joint failure. Test it yourself. Write for a sample on your letterhead today. Don't wait until it's too late!

J. H. FRANCE REFRACTORIES COMPANY
Department P 3125 France Road
Snow Shoe, Pennsylvania
In Canada: Standard Refractory Ltd., Hamilton, Ont.

For more data circle 555 on Post Card

entire range, a micro-meter adjustable pointer, and all stainless steel system. Gages are enclosed in black enameled aluminum cases with chrome plated slip ring, with brass separable socket and extension neck. They are also available with compensated lines up to 200 ft long. Sockets are interchangeable for ½, ¾ or 1 in. NPT in standard 3½- and 6-in. extension neck types. Case design permits installation for adjustable angle, rigid or remote reading. Dial sizes are 4½, 6 and 8½ in., and there are six standard ranges from −20/100 F to 100/400 F. Weksler Instruments Corp.

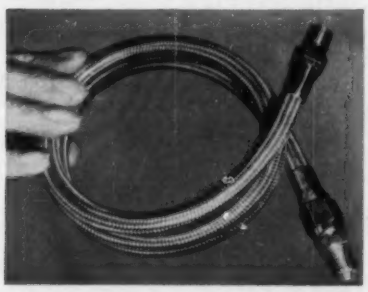
24—AIR POLLUTION CONTROL is interphase reaction type

With the Yerzley Scrubber, operating on the principle of interphase reaction, high intimate contact is said to be achieved through a wet-bed packing

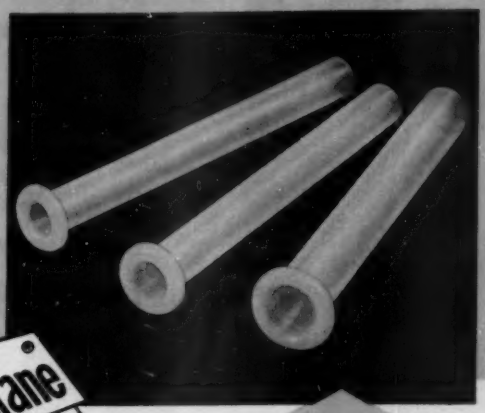
only a few inches deep and maintained in a flooded condition. Through use of this technique, high absorption efficiencies are obtained in the compact unit, manufacturer states. This air pollution control device is reported successful in removal of fumes from hydrochloric, sulfuric, nitric and hydrofluoric acids; complex nitrogen oxides; alcohol; acetone; ammonium chloride; hot vegetable oils; sulfur compounds; hot grease vapors. John Wood Co.

25—FLEXIBLE HOSE built to transmit live steam

White Line Steam Hose incorporates an extruded Teflon (TFE) innercore, bronze wire reinforcing braid and swaged fittings to provide reliability with resistance to deterioration, abrasion, scaling, blowoffs and leakage. The TFE innercore won't embrittle, work harden or deform even after millions of flexing cycles at 400 F, and resists most chemicals, it is claimed. The bronze wire protects against rust and is braided in a pattern designed for flexibility with

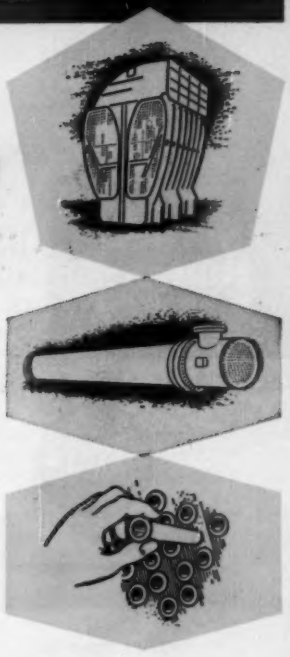


Lengthen Condenser and Heat Exchanger Life



John Crane

Plastic* Tube Protectors

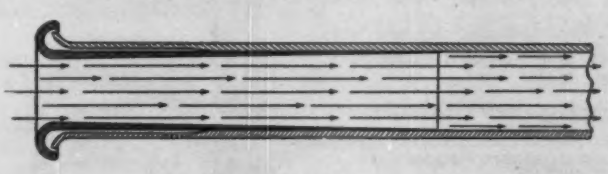


- Protect tube ends for life of tube.
- Positively prevent erosion and abrasion.
- Reduce costly tube maintenance and replacement.
- Easy to install—just slip into tube inlet after coating outer surface with cement.

* Nylon, Polyethylene or Phenolic Resin

PLUS EXCLUSIVE FREE-FLOW DESIGN

Wall thickness gradually tapers toward discharge end. Assures smoothest possible water flow, eliminates turbulence.



Get the facts. Request new Bulletin P-335.

John Crane® CRANE PACKING COMPANY

6429 Oakton Street, Morton Grove, Illinois (Chicago Suburb)
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

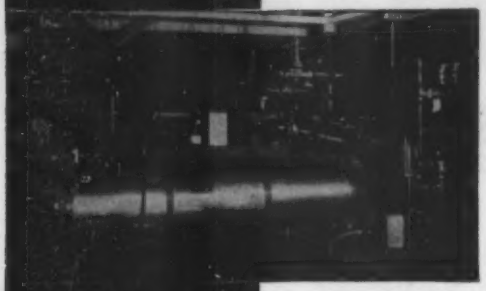
For more data circle 556 on Post Card

ENCO

Fuel Oil Pumping and Heating Systems

For heavy bunker oil or light furnace oil . . . 100 to 10,000 gallons per hour

Enco systems employ one, two or more pumps and heaters, interconnected so that full capacity is possible with any combination of pumps and heaters. Flexibility of design permits the use of any combination of rotary pumps, with motor or turbine drive; or piston type steam pumps. Any part may be cut out of operation for inspection or cleaning, without shutting down, where two or more pumps and heaters are included in the unit system.



Heaters are insulated and jacketed with removable heads at both ends for cleaning without breaking any piping connections or removing any tube bundles.

Full automatic oil pressure and temperature control, with relief valves for each pump and heater. Permits delivery of oil with safety, and at proper temperature and pressure for efficient burning.

Each unit is built to order and delivered ready to place on foundation and for connection to the station piping.

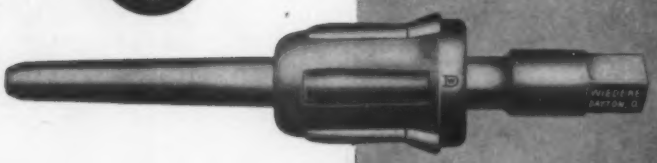
Write for Bulletin OB-53 describing Enco Gas and Oil Burners; and Pumping and Heating Equipment.

THE ENGINEER COMPANY
75 WEST STREET
NEW YORK 6, N. Y.

ac 806

For more data circle 557 on Post Card

IDEAL



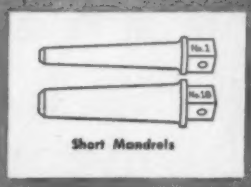
For modern Water Tube Boilers

Series 1500 Tube Expanders

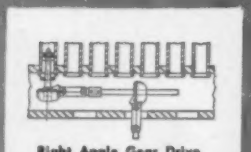
. . . Recommended for use with Drum or with short Header Mandrels.

Right Angle Drive speeds-up rolling operation of any Tube inside round or square Header.

See your Dealer or write us for Bulletin.



Short Mandrels



Right Angle Gear Drive

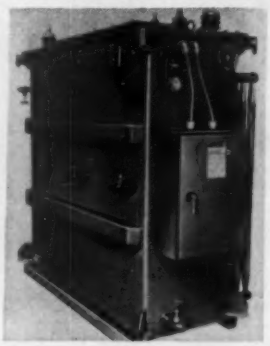
The Gustav WIEDEKE Company
DAYTON 1, OHIO

For more data circle 558 on Post Card

long fatigue life and burst strength. Fittings are installed with compact swaging dies. The fitting is assembled and forced into the die which contracts the collar around the fitting body — male or female unions, elbows or straight tube fittings may be assembled. This can be done with a small hydraulic press supplied by manufacturer, or with a hand arbor. This hose is available either as assembled lengths or as specialized lengths with separate fittings to be assembled at user's plant. Sizes range from ¼ to 1 in. Titeflex Inc.

26—VOLTAGE REGULATORS for three-phase load

Type SVR-FT Feeder-Voltage Regulators are designed for use wherever a three-phase load is to be regulated to a desired voltage level. The 60-cycle, three-phase, step-type regulators are rated 500 and 750 kva for 8.66 or 13.2 kv circuits. They are automatic



and self-contained, manufacturer points out; any voltage variation due to supply voltage change or variation due to load circuit change is detected by control and correction made. Unit features 16-step voltage regulation over a 20 per cent range, and a type CVR relay which incorporates both voltage regulating device and time delay. Relay serves to operate tap changer mechanism, restoring load voltage to normal when load-voltage fluctuations become too large for safe operation of industrial machinery. It also gives rapid correction of abrupt voltage changes and narrower effective bandwidth. Each phase has its individual tap changer in separate compartment, preventing interchange of oil. Westinghouse Electric Corp.

27—PIPE COVERING is flexible, ozone resistant

Major improvements in this company's foamed plastic pipe covering insulation are said to give it a higher temperature range, ozone resistance and smoother surface. The improved product, Armaflex 22, is for use on liquid cooling and heating lines, chilled water lines and other cold lines in plumbing, heating, air conditioning, refrigeration and processing applications. Manufacturer says it can be used from below zero to 220 F and applied to sharp bends and elbows without fissuring or cracking at the area under strain.

This insulation, with its average density reduced to 7 lb per cubic foot, has a smooth, uniform outer surface finish, resulting in a neat looking installation, unfinished or coated. Its closed cellular structure gives it a low value of 0.28 at 75 F mean tempera-

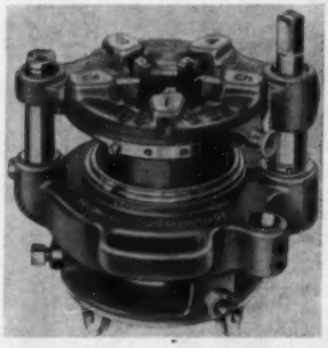
ture, it is stated, and it resists moisture and deterioration with the result that thermal efficiency remains high in service. Its flexibility facilitates application, even in close quarters. Armaflex 22 comes in three wall thicknesses, each calculated to prevent condensation on cold lines within their recommended usage ranges. For below-zero temperatures, Armaflex 22 is applied in multiple thicknesses. Armstrong Cork Co.

28—CENTRIFUGAL PUMP for hazardous liquids

This seal-less (canned) centrifugal pump is introduced for leak-proof handling of hazardous liquids (volatile, toxic or inflammable). It has no mechanical seal, stuffing box or gland. These features are the result of combining the motor and pump in an integral unit. Built in two sizes with 1- and 1¼-in. discharge, pumps have a capacity range to 110 gpm., heads to 100 ft, and are designed for handling clear liquids only. Motor cooling and parts lubricating is accomplished by circulating a controlled portion of the liquid being handled through the hermetically sealed rotor housing and the grooved bearings. Pumps are equipped with a built-in thermal cutout device that protects the motor if the motor winding temperature exceeds the maximum limit. They are supplied in 316 (CF8M) stainless steel but other materials can be furnished. Data given in Bulletin 728.1. Goulds Pumps, Inc.

29—PIPE THREADER has several time saving features

Now 2½–4-in. pipe and conduit can be threaded without changing dies, it is announced, with the Ridgid 141 Jam-Proof Geared Threader. Just one set of dies

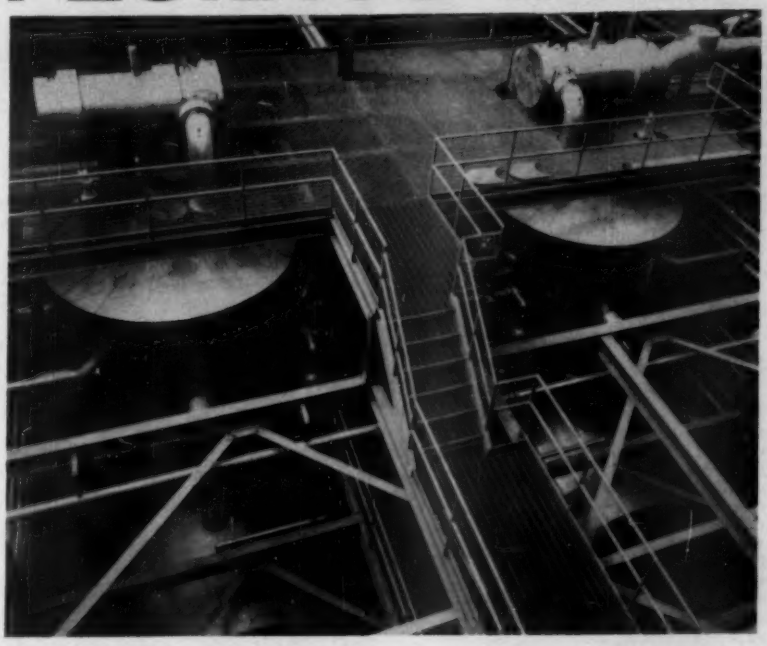


threads 2½, 3, 3½ and 4 in., company says, and threader adjusts for straight or tapered, over and under size threads. Drive pinion of the jam-proof threader kicks out automatically. Cam-action workholder sets to size by turning of adjusting collar. The Ridge Tool Co.

30—LOAD CONTROLLER for machines using a-c motors

This motor load-controller, designed to sense "real" load in kilowatts, is for use with machines using a-c induction motors for driving power. It operates with single- or three-phase systems at 110, 220 or 440 v, manufacturer explains, sensing both voltage and current and measuring the phase angle between them. It will sell for around $200.

FLUIDICS* AT WORK



How they're saving feedwater dollars at L.A.'s new Scattergood Steam Plant

Each of these two 12'-diameter, 1,036,250-lb/hr-capacity Permutit spray-type deaerators, nests atop its own 160,000-lb. storage tank in the new Scattergood Steam Plant at Los Angeles. The only open direct-contact-type heater with five closed heaters operating on the regenerative cycle, each deaerator operates at 20 psia to 52.8 psia. Design pressure is 100 psig, ASME code.

These deaerators process boiler feedwater for normal throttle steam conditions of 1800 psig at 1000° F with 1000° F reheat.

The City of Los Angeles can't afford to have corrosive oxygen or CO_2 in that water.

And it doesn't, because Permutit deaerators are *guaranteed* to remove all free CO_2 and to reduce oxygen to less than 0.005 m. per liter.

Save money

These deaerators save operating dollars because they have several advantages over tray or other types of deaerators. Maintenance is minimized, due to simplicity of design. Uniform, wasteless distribution of steam through water in scrubber, at *all* rates of flow from zero to full capacity. No water hammer, no rumbling—in short, quiet operation.

Besides these heaters, two more Permutit deaerators are used at Scattergood to prepare feedwater for evaporators.

Ultimately, Scattergood will have four generating units producing a total of 1,200,000 KW, almost equalling Hoover Dam. There's no room for boiler troubles in this kind of operation.

30-page bulletin

You can get the same feedwater purity and dollar savings, with Permutit deaerators (3000 to 3,000,000 lb/hr) and other water treatment facilities available through our Fluidics program. To start, send for our fact-filled 30-page bulletin, "Spray Type Deaerating Heater."

For more information, write PERMUTIT Division, Dept. PE-50, 50 West 44th Street, New York 36, N. Y., or call your local Permutit representative. In Canada: The Permutit Company of Canada, Ltd., 207 Queens Quay West, Toronto, Ontario.

*FLUIDICS is a complete, imaginative Pfaudler Permutit program which economically provides practical answers to problems involving fluids and gases.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS...the science of fluid processes

For more data circle 559 on Post Card

Function of the mechanism is to continuously measure real load on a drive motor and to either actuate a visible or audible alarm, or shut down the machine to prevent damage in case load becomes too great due to malfunction — such as tool breakage on a machine tool. According to manufacturer, most controllers sense load by simply measuring current, a method giving only an approximate measure of torque within a limited range. This instrument measures load in kilowatts and indicates measurement in percentage of rated load from zero to any overload percentage. Fixed loads, such as normal friction in a drive member, can be balanced out if desired, so that the system senses only loads exceeding a fixed level. Seneca Falls Machine Co.

31—EPOXY FLOOR with increased corrosion resistance

Measurably greater chemical resistance than present floor formulations is claimed for this epoxy floor, which is announced as resistant to most acids, alkalies and solvents. Also, because it cures quickly and withstands abrasion, manufacturer suggests it for resurfacing worn floors where speed is essential. It is a topping, approximately 1/8 to 3/16-in. thick, applied to a previously prepared slab, usually concrete. It can be made skid-proof. Company bases its claim of superiority on laboratory tests — involving acetic, hydrochloric, sulfuric and nitric acids — showing that this floor absorbs less liquid in total submersion tests than do other epoxy floors. Kalman Floor Co.

32—HOISTING UNITS offer more safety for overhead jobs

The Electair line of lightweight swing stage hoisting units can be adapted to scaffolding, climber basket or bosun's chair operations. Four models are included — two electric-powered, one pneumatic-powered and one hand operated — all redesigned for greater safety and operating flexibility. Hand and air

powered units have a 1000-lb capacity. Electric models (shown rear, at left, and front) adapted to either 115- or 230-v power by the turn of a switch, have a 600-lb capacity with a 1/2-hp motor or a 900-lb capacity with 3/4-hp motor. Pneumatic and electric models can be raised or lowered at 18 fpm. The units feature five safety devices, two of which are in the control mechanism — a self-actuating cam lock and a self-actuating pawl lock which serve to automatically engage the cable and drive gear in event of slippage. There is also a disk type brake and spring loaded power control. Ohio Hoist Mfg. Co.

33—VOLTAGE RECORDER is narrow-range instrument

For plants requiring close, accurate a-c voltage checks, this instrument is designed to provide a continuous record of fluctuations between 110 and 130 v on a 10 3/4 in. calibrated scale and strip-chart. Accuracy is given as ±0.25 per cent of mid-scale voltage. In operation, the recorder uses the stable voltage characteristics of a silicon diode to compare forward and reverse half-cycles of the input voltage. This produces an average d-c voltage proportional to the input RMS voltage, which is then measured using a potentiometric null-balance recorder mechanism.

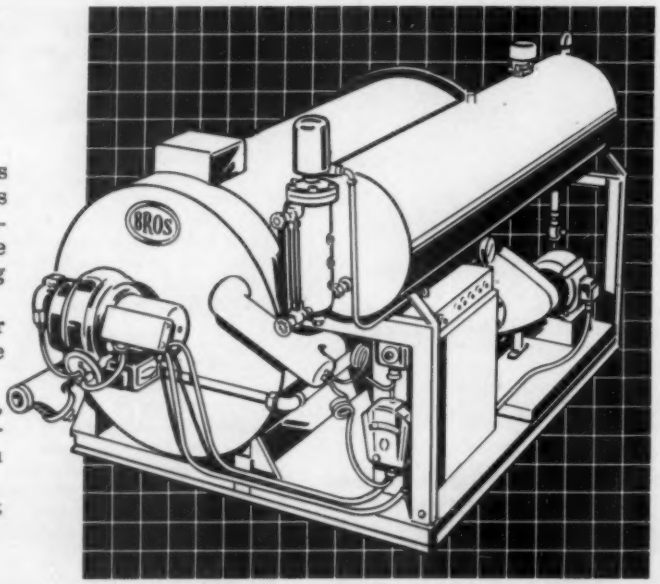
The recorder is available for both 50- and 60-cycle systems. Chart speeds range from 1/2 to 360 in. per hour; response time from 1 to 24 sec. can be had. Ease of maintenance is aided by a hinged mechanism panel that swings out to allow access to components within the instrument. Components are isolated by function. Recorder is adaptable for surface or semi-flush mounting. It is 17 11/16 in. wide, 16 3/16 in. high, 17 1/16 in. deep. General Electric Co.

34—SYNTHETIC BELT designed to resist stretching

REVO is described as an improved, double-strength, all-synthetic transmission belting with "molecular memory" that makes it practically stretch-free. It is made by a method orienting nylon bands and a woven nylon cloth. A high coefficient of friction is obtained by coating the pulley side of the belt with urethane. Processing of the nylon bands

HEAT PROCESSING NEEDS OF UP TO 600° F.?

BROS Liqui-Therm Heaters Provide these at Low Working Pressures



● The BROS Liqui-Therm Heater provides 850,000 to 50,000,000 BTU requirements for modern industrial processing high temperature demands of up to 600° F. These temperatures are produced at working pressures below 15 psi.

A variety of heat transfer media under forced circulation can be used to achieve accurate control of high temperatures.

BROS Liqui-Therm Heaters, Watertube, Package, and Cornertube® High Temperature Water Boilers are available through a national sales organization.

Write for full information and nearest dealer.

BROS **BROS** *Incorporated* *Power Division*

1057 TENTH AVENUE S. E. • MINNEAPOLIS 14, MINNESOTA

For more data circle 560 on Post Card

NEW DE-LINE annunciator has

70% MORE ENGRAVING AREA for more precise trouble legends

PA-102 LOW PRESSURE MILL ROLL LUBRICATING OIL

Scam De-Line annunciators, your systems' sentry, now offers the new MAGNA-PLAC nameplate which provides 70% more engraving area.

The MAGNA-PLAC nameplate gives the engineer increased space to more accurately describe condition variations or to employ larger characters for greater visibility. It is interchangeable with standard Scam nameplates and optionally available *without extra charge.*

Other De-Line features include side or stack mounting for practical, *economical* system expansion; a single plug-in relay for both normally open *or* normally closed contacts; and sequence options *after* installation.

Yes, continuous product improvements such as MAGNA-PLAC, flexible application, ruggedness and reliability are what make De-Line the engineer's annunciator.

Complete Monitoring Systems for Industry

SCAM®

INSTRUMENT CORP.

Dept. A, 1811 W. Irving Park Rd.
Chicago 13, Ill.

Representatives in Principal Cities

WRITE FOR MORE INFORMATION on De-Line MAGNA-PLAC. Just sign and attach coupon to company letterhead.

NAME _____

sets their molecular structure permanently, it is explained, and as a result, the belt is almost 100 per cent stretch-free. According to manufacturer, this belt gives under loads, but its "molecular memory" returns it to original length or tension — when properly installed it can be run indefinitely without take-up or idlers. Also, increased strength of the belt is said to permit use of thin belts at high speeds around exceptionally small pulleys. REVO has high resistance to temperatures and humidity, oils and many acids, and will accept a maximum temperature of approximately 200 F, company states. Belts can be furnished endless or made endless with available lapmaking machines. L. H. Shingle Co.

Reader Service Cards on pages 105–106 make it easy to get further information on any of these products. Just circle the item numbers of the products you want to know more about.

35—GLASS TAPE for banding rotating apparatus

This B-stage polyester-treated glass banding tape is designed for banding armatures, other rotating apparatus and for tying, supporting and anchoring electrical components that require use of a high-strength nonconducting material. Though designed for use in Class B service, manufacturer says the material can be used at higher temperatures for short periods. The tape employs parallel glass strands and nonglass cross fibers to minimize longitudinal splitting and provide high cross strength. It is described as non magnetic, having ultimate and yield strengths of 140,000 psi, and noninductive, dielectric strength over 400 v/mil. For use in conjunction with the glass banding, tape cut from B-stage polyester-treated glass fabric is available as a finish wrap over roving or restraining wall. Both banding tape and finish-wrapping tape use the same uncured and stabilized polyester resin. Westinghouse Electric Corp.

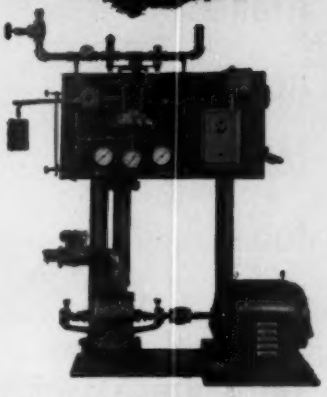
ANSWER

to Worthington "Hidden Value" Puzzle on Back Cover

The fictitious "hidden value" is *Adjustable Roller Main Bearings.* The design of any balance opposed compressor makes roller bearings impractical from a maintenance standpoint. Worthington balanced opposed compressors use centrifugally cast sleeve bearings which can be removed for inspection or maintenance without disturbing the crankshaft or removing the connecting rod from the frame.

Cut Steam Costs

with Stickle's differential drainage and boiler return system



A closed pumping system for returning condensation from heating and processing equipment under pressure directly to boiler at temperatures only 15 to 20 degrees lower than those at operating pressure. For plants using steam pressures between 50 and 250 lbs. Cuts the cost of steam these eight ways:

1. Cuts fuel costs 10% to 25% by completely salvaging condensate and returning to boiler at 300 degrees or higher.
2. Raises production with higher, more uniform boiler pressure, higher temperature steam.
3. Reduces use of raw make-up water 85% to 90%.
4. Cuts maintenance on boilers, steam lines, traps and valves.
5. Improves quality by permitting operation of processing units at peak efficiency.
6. Cuts power used for pumping up to 75%, since system requires only 25 lbs.
7. Automatically maintains positive circulation without steam loss.
8. Eliminates flash steam waste.

FREE BULLETIN!
Write or wire for details and free Bulletin 250.

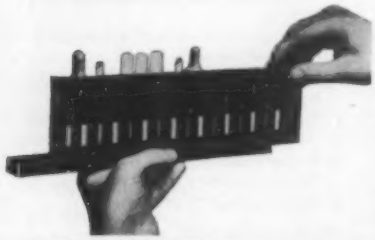
STICKLE STEAM SPECIALTIES CO.
2241 Valley Ave. • Indianapolis 18, Ind.
SINCE 1905

Stickle Equipment
Cuts the cost of steam

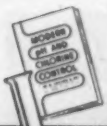
Steam Traps • Feed Water Heaters
Regulating and Reducing Valves
Drainage and Boiler Return Systems

For more data circle 562 on Post Card

1-
2-
3 steps
and
you
make
accurate
tests
for
pH,
phosphate,
nitrate
with
TAYLOR
COMPARATORS



GUARANTEED
NON-FADING
COLOR STANDARDS



WRITE FOR FREE HANDBOOK
101 pages of technical data and useful information. Gives theory and application of pH control. Describes Taylor line.

W. A. TAYLOR AND CO.
410 STEVENSON LANE • BALTIMORE 4, MD.

For more data circle 563 on Post Card

ADVERTISERS' INDEX

Aerovent Fan Co., Inc. ..... *
Air Preheater Corp., Inc. 26
Airetool Mfg. Co., The 100
Allis-Chalmers Mfg., Co. ..... *
Aluminum Company of America 12-13
American Brass Co. 5
American Chain & Cable Co. Automotive & Aircraft Div. 122
American Engineering Co. ..... *
American Hard Rubber Company ..... *
American Pulverizer Co. ..... *
American-Standard Industrial Division ..... *
Armstrong Machine Works 7
Atomics International ..... *
Automotive & Aircraft Div. American Chain Cable Co. 122

Babcock & Wilcox Co., The Boiler Div. ..... Cover II-1
Bailey Meter Company ..... *
Baldwin-Ehret-Hill, Inc. ..... *
Baltimore & Ohio Railroad 97
Barco Manufacturing Co. 94
Beckman Instruments, Inc. ..... *
Betz Laboratories, Inc. 14-15
Biddle Co., James G. 96
Bird-Archer Co., The ..... *
Bituminous Coal Institute ..... *
Black, Sivalls & Bryson, Inc. ..... *
Bros Incorporated 118
Brown Boveri Corp. 109
Buffalo Forge Company 47
Bussman Mfg. Co. ..... *
Byron Jackson Pumps, Inc. ..... *

Calgon Co. ..... *
Cambridge Instrument Co., Inc. 122
Carling Turbine Blower Co. ..... *
Childers Mfg. Co. ..... *
Combustion Engineering, Inc. 18-19
Copes-Vulcan Div., Blaw-Knox Co. 22-23
Crane Co. ..... *
Crane Packing Co. 115
Cyclotherm Div. National-U.S. Radiator Corp. ..... *

Davis Engineering Corp. ..... *
Detroit Stoker Company 111
Diamond Power Specialty Corp. 107

Eagan Co., Inc., Walter H. ..... *
Eastern Gas & Fuel Associates 33
Edison, Thomas A. ..... *
Edward Valves, Inc. 16-17
Elliott Co. 92, 121
Ellison Draft Gage Co. ..... *
Engineer Co., The 116
Erie City Iron Works 10-11
Everlasting Valve Co. ..... *

Fairmount Chemical Co., Inc. 112
Fisher Governor Co. ..... *
Flexonics Corp. ..... *
Foster Wheeler Corp. 85
Franco Refractories Co., J. H. 114
Fuller Co. ..... *

General Coal Co. ..... *
Globe Co., Products Div. ..... *
Goodall Rubber Co. 101
Green Fuel Economizer Co., Inc., The ..... *
Grinnell Co. 87
Gruendler Crusher & Pulverizer Co. ..... *

Hagan Chemicals & Controls, Inc. 28
Hall Laboratories ..... *

Illinois Water Treatment Co. ..... *
Industrial Instruments, Inc. ..... *
Information Systems, Inc. ..... *
Island Creek Coal Sales Co., The ..... Cover III

Johns-Manville 38-39
Johnson-March Corp. 93
Jordan Corporation ..... *
Joy Mfg. Co. 2

E. Keeler Co. ..... *
Kirk & Blum Mfg. Co. ..... *
Kulijian Corp. ..... *

Lear, Inc. ..... *
Leslie Co. 34-35
Librascope, Inc. ..... *
Lonergan Co., J. E. 114

Manning, Maxwell & Moore, Inc. 20, 40
Marley Co., The ..... *
Massey Coal Co., Inc., A. T. ..... *
Milton Roy Co. 99, 112
Moore & Co., Samuel 98
Morton Salt Co. ..... *
Murray Iron Works Company 95

*Firms whose advertising is not in this issue but is appearing in other issues are marked with an **

Nagle Pumps, Inc. ..... *
Nalco Chemical Co. 25
Niagara Blower Company ..... *
North American Mogul ..... *

Palmer Thermometers, Inc. ..... *
Peabody Coal Co. 46
Pfaudler Permutit Inc. 117
Pfizer & Co., Chas. ..... *
Pickands Mather & Company 89
Pipe Fabrication Institute ..... *
Pittsburgh Corning Corp. ..... *
Pittsburgh Piping & Equipment Co. ..... *
Powell Valves, Wm. 45
Powers Regulator Co., The ..... *
Pratt Co., Henry ..... *

Raybestos-Manhattan, Inc. 113
Refractory & Insulation Corp. ..... *
Reliance Gauge Column Company ..... *
Republic Flow Meter Co. 83
Ric-wil, Inc. ..... *
Riley Stoker Corporation 36-37
Roto Div. of Elliott Co. 90

Sarco Company, Inc. 102, 103
Scam Instrument Corp. 119
Solar Aircraft Co. ..... *
Spence Engineering Co. 24
Standard Oil Co. (Indiana) ..... *
Stephens-Adamson Mfg. Co. ..... *
Stickle Steam Specialties Co. 119
Stock Equipment Co. ..... *
Stone & Webster Engineering Co. ..... *
Superior Combustion Industries, Inc. 104

Taylor & Co., W. A. 120
The Terry Steam Turbine Co. 30
Thermo Electric Co., Inc. ..... *

Union Iron Works ..... *
United Electric Coal Companies, The ..... *
Universal Atlas Cement Co. ..... *

Valley Camp Coal Co., The 27
Vogt Machine Co., Henry 29

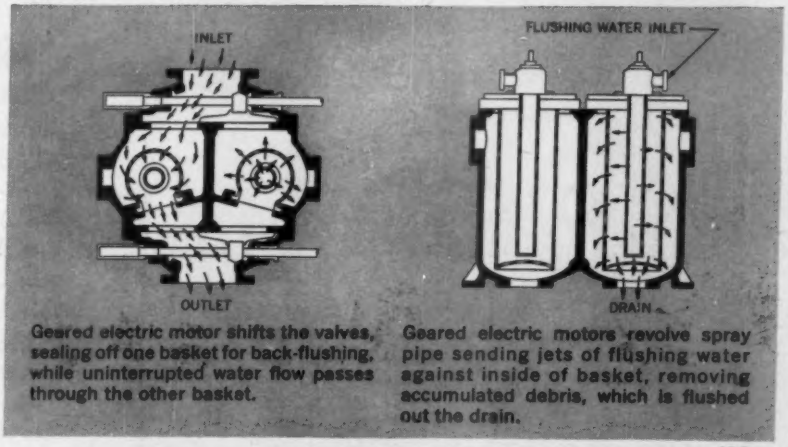
Western Chemical Company ..... *
Western Precipitation Corp. 91
Westinghouse Electric Corp. ..... *
Wiedeke Co., The Gustav 116
Williams Gauge Co. ..... *
Wilson, Inc., Thomas C. ..... *
Worthington Corporation ..... Back Cover

Yarnall-Waring Company 8-9, 48
Yuba Consolidated Industries, Inc. 21

Elliott motorized back-flushing twin strainers

FOR HEAVY-DUTY INDUSTRIAL SERVICE

● This Elliott type A Twin Strainer is built to handle 2000 gpm of river water ● provides continuous flow of clean water for New Jersey industrial plant ● geared electric motors shift the valve discs and operate the rotary spray pipes ● this design is capable of handling extremely bad water ● one basket is automatically cleaned while water flows through the other basket, assuring continuous service.



Geared electric motor shifts the valves, sealing off one basket for back-flushing, while uninterrupted water flow passes through the other basket.

Geared electric motors revolve spray pipe sending jets of flushing water against inside of basket, removing accumulated debris, which is flushed out the drain.

AO-2

Contact your nearby Elliott District Office or write Elliott Company, Strainer Department, Jeannette, Pa., for complete descriptive details.

ELLIOTT Company

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS

For more data circle 564 on Post Card

CHECK BOTH

OXYGEN
in the feedwater

HYDROGEN
in the steam

OXYGEN is well known to be an active source of boiler corrosion. The oxygen dissolved in feedwater is determined directly and continuously recorded upon the Cambridge Dissolved Oxygen Recorder.

The oxygen set free by dissociation of the water in the boiler is equally damaging. Its presence is determined by measuring the free hydrogen in the steam condensate. Cambridge Analyzer-Recorders provide continuous records of both the oxygen dissolved in the feedwater and the hydrogen in the steam — on one chart if desired, thus enabling prompt corrective measures to be taken.

Complimentary copies of these bulletins will be sent upon request.

A.S.T.M. BULLETIN D1588-58T

Describes the approved referee method of testing for gaseous hydrogen in industrial water.

CAMBRIDGE Bulletin No. 146 BP

Describes both the CAMBRIDGE Dissolved Oxygen and Dissolved Hydrogen Analyzers.

Instrument shown may be used to record either O_2 or H_2 or both simultaneously. Cambridge also makes Hydrazine Analyzers, PH Recorders and instruments for analyzing gaseous mixtures.

CAMBRIDGE INSTRUMENT CO., INC.

1620 Graybar Bldg., 420 Lex. Ave., New York 17, N. Y.

CAMBRIDGE

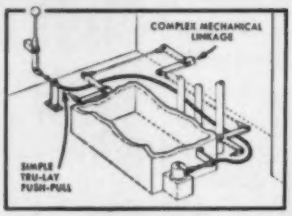
Dissolved O_2 & H_2

ANALYZERS

Pioneer Manufacturers of Precision Instruments

For more data circle 565 on Post Card

TRU-LAY PUSH-PULL DATA FILE SHOWS HOW TO SIMPLIFY AND IMPROVE DESIGN



Push-Pull remote controls, shown here, are flexible, have but one moving part, and give a lifetime of accuracy. Mechanical linkages are complex, are made of many parts, wear at many points, and produce increased backlash, lost accuracy, and vibration rattles.

This Push-Pull Data File—containing 7 engineering bulletins—will show you how these flexible controls have eliminated mechanical linkages on hundreds of products. You can make *your* products more useful, easier to sell, with Push-Pull controls. Write for your Data File today.

Automotive and Aircraft Division

AMERICAN CHAIN & CABLE

ACCO

601-M Stephenson Bldg., Detroit 2
6800-M East Acco Street, Los Angeles 22
929-M Connecticut Ave., Bridgeport 2, Conn.

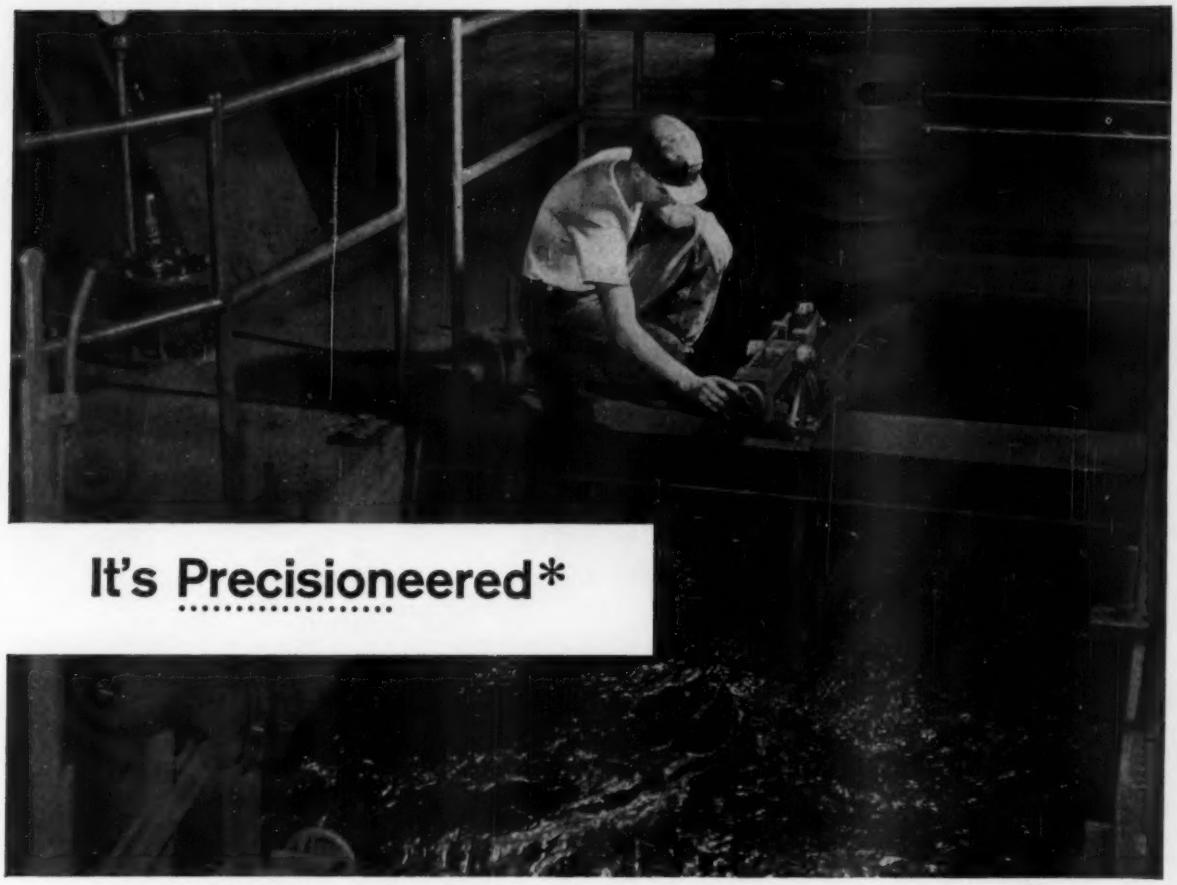
For more data circle 566 on Post Card

The easiest—and quickest—way to order bulletins and catalogs described in this magazine is to use the postage-free Reader Service Cards on pages 105–106.

All you need to do is circle the item numbers of those you want. Then fill in your name, job title, company name and address—and mail the card.

You may also use the Reader Service Cards to request information on products described, or literature mentioned in the ads—just circle the number below the ad.

What's the reason? Why can Island Creek coal lower the cost per 1000 pounds of steam?...



It's Precisioneered*

Washed coal stores better, handles better, and results in lower equipment maintenance costs.

* Everything that happens to a Precisioneered Coal at Island Creek is designed to make it do its job most efficiently, at the lowest possible cost. It starts at the mine face—with superior seams of eastern coal. It continues through the modern preparation plants where precision engineering techniques and strictest laboratory controls assure a product that will produce steam—in your equipment—at the lowest net cost per 1000 lbs. We'd welcome a chance to discuss the far-reaching engineering service and evaluation studies that are also part of Island Creek Precisioneering—and which can forecast in advance what can be done to lower net costs. Write. Or phone. No obligation, of course.

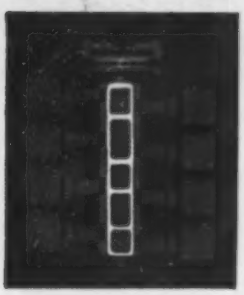
ISLAND CREEK
Precisioneered Coal

You can depend on Island Creek . . . a career company dedicated to coal

Island Creek Coal Sales Company, Chafin Building, Huntington 18, West Virginia • Chicago • Cincinnati • Cleveland • Detroit • Greensboro • New York • Pittsburgh

For more data circle 567 on Post Card

WILL YOUR NEXT BALANCED OPPOSED COMPRESSOR HAVE ALL OF THESE "HIDDEN VALUES"?



No, it won't! Even if you choose a Worthington compressor, you'll get only 23 of the 24 "hidden values" pictured below. (Just to pique your interest one is fictitious. For identification of the phony feature, see page 119.)

Compressors should be evaluated on performance, we think you'll agree. But performance is determined by factors which aren't easily checked against service conditions and data. These are the factors we call "hidden values." It will pay you to evaluate these values the next time you specify a compressor. Worthington Corp., Clinton Street and Roberts Ave., Buffalo 5, N. Y. 36-8

WORTHINGTON

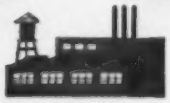
OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

WIRE ALIGNMENT during assembly using electronic equipment minimizes field alignment problems.

FACTORY ASSEMBLY of intercooler and interstage piping reduces installation problems and costs.

COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.

HONING of connecting rod crankpin and crosshead pin ends results in tighter fits, no loose shells.

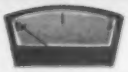


INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

ULTRASONIC TEST—an advanced method of examining certain critical parts for internal quality.

$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

ANALOG/COMPUTER simulates wide range of actual operating conditions for optimum design analysis.



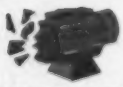
PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

KOLENE PROCESS removes impurities from bearing shell that weaken bond between it and babbitt.

CAST-IN LUBE OIL SYSTEM with internally drilled oil passages eliminates crankcase "plumbing."

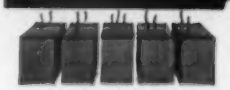
MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

FINISHED GROUND BEARING SHELLS provide positive full-contact backing for long life.



DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

REMOVABLE DOWEL locks piston rod to crosshead—prevents turning due to loosened crosshead nut.



PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

FEATHER VALVE—industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

STEEL TIE BAR, keyed and bolted in place, strengthens frame and maintains the original alignment.

CROSSHEAD SLIPPER ADJUSTMENT within one-thousandth of an inch assures much longer packing life.

THERMODYNAMICS SECTION analyzes each application to size unit and determine its performance.

SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

AIR CONDITIONED GAUGE ROOM has master gauge blocks constantly used to check instruments.